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Student Teaching Practicum at Forest Grove Middle School

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Teaching Practicum in Science at Forest Grove Middle School

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Chapter 1: Background

Massachusetts Education Reform Act of 1993

Public education can be considered one of the most essential institutions to American society. However, it is often under much scrutiny. In June of 1993, Massachusetts looked to improve public education as a whole. The Massachusetts Education Reform Act (MERA) was signed by Governor William Weld as a way to increase the state role in funding public education and guiding the local educational process. Essentially, the act required the establishment of high academic standards that every student would be required to meet, a statewide assessment system aimed to measure the progress of a student towards an educational goal, and a system that would hold schools and districts accountable for all students progress in reaching the statewide standard. It changed the state's role to incorporate curriculum frameworks, as well as, it held schools responsible for student performance. In order to make the MERA successful, the act highlighted nine areas of reform: (Driscoll, 2003)

1. Increased State Funding for Public Education
2. A "Foundation Budget" for All Districts
3. Learning Standards
4. Student Assessment
5. An Accountability System for School and District Performance
6. Changes in Local Education Governance and Management
7. Enhancing Educator Quality
8. Ensuring Readiness to Learn Through Early Childhood Education Programs
9. Implementing Choice and Charter Schools (Driscoll, 2003)

Of these nine reforms the implementation of increased state funding has been extremely effective. Starting in 1993, MERA required an allocation of $5500 per student education. This allowed states to see which districts would need more assistance and guarantee that every district would have proper funding. In total, MERA doubled state funding of K-12 education from $1.3 billion in 1993 to $2.6 billion in 2000. The overall increase in funding is one of the greatest accomplishments of MERA. (Driscoll, 2003)

Another reform that has been highly effective is the implementation of a student assessments. Along with MERA, the Massachusetts Comprehensive Assessment System, or MCAS, was created. This test was created to assess student learning. It is administered in multiple grades, 3-8 and 10, and in multiple subject, including English language arts, mathematics, reading, science/technology/engineering, and history/social science. The tests are used to see an individual student as well as a districts proficiency. The proficiency levels are tested against the Massachusetts Curriculum Framework, which was also created by MERA. The frameworks has subject learning objectives, requirements, and models on how to structure subjects. Originally, MERA was set up to be carried out throughout a seven year long period, however, with the success of the act the standards continued to be used. MERA has had a lasting impact on Massachusetts education, so much so, that in 2017, Massachusetts was ranked as the #1 state in education by U.S. News and World Report. (Driscoll, 2003)

Massachusetts International Performance Comparison

The Massachusetts education system is a force to be reckoned with. Through international testing, i.e. TIMSS and PISA, Massachusetts ranks high in subjects such as math, science and reading when compared to states and other countries.

Trend in International Mathematics and Science Study (TIMSS) is used to compare U.S students to other countries in mathematics and science achievement. Data has been collected every 4 years from students in grades 4 and 8 since 1995. TIMSS has also added a TIMSS advanced which measures advanced mathematics and physics achievement in the final year of secondary school. This data has been collected three times in 1995, 2008, and 2015. Massachusetts is considered a benchmark state for the TIMSS. This means the data collected from this test can be used to compare Massachusetts internationally. The test is used to compare different counties to one another as well as states to states and states, like Massachusetts, to other countries. 2011 TIMSS test data showed that Massachusetts ranked extremely high compared to other counties in science and math. 8th grade science results showed that Massachusetts' public school students' average score was 567. This is higher than both the TIMSS scale average, which was 500, and the U.S average, which was 525. Massachusetts scores in science were higher than 50 other countries and states that participated in the testing, was not measurably higher then 4, and only scored lower than Singapore. (TIMSS 2011 results for Massachusetts: Science - Grade 8, 2013)

The 2011 TIMSS math scores were just as impressive as that of science. The Massachusetts state average for 8th grade students was 561 as compared to the TIMSS scale average of 500 and the U.S average of 509. Massachusetts also scored higher than 50 other countries and states on the 2011 math exam, was not noticeably different the 1 country, Japan, and only scored lower than four countries or schools, Republic of Korea, Singapore, Hong Kong, and Chinese Taipei. (TIMSS 2011 results for Massachusetts: Mathematic - Grade 8, 2013)

Another test that is used to evaluate different countries or states is PISA. PISA stands for Program for International Student Assessment. It is "an international assessment that measures 15-year-old students' reading, mathematics, and science literacy every three years." (National Center for Education Statistics [NCES], n.d.-a) PISA was first given out in 2000 and was designed to "emphasize functional skills that students have acquired as they near the end of compulsory schooling." (NCES, n.d.-a)

Like TIMSS, Massachusetts scored very well on all three subjects tested by PISA in 2012, math, science, and reading. Massachusetts average score for the mathematics test was 514, compared to the U.S average of 481 and international average of 494. Figure 1 shows the PISA mathematics literacy scale in Massachusetts public schools compared with other participating education systems in 2012. Massachusetts average scores in science were also above the U.S and international average. Massachusetts scored an average of 527 on the science PISA test, whereas the U.S average score was 497 and the international average was 501. Figure 2 show the PISA science literacy scale in Massachusetts public schools compared with other participating education systems in 2012. Finally, Massachusetts scored exceptionally well on the 2012 reading

PISA. Massachusetts average score was 29 points higher than the U.S average and 31 points higher than the international average. Massachusetts average score was 527 whereas the U.S scored an average of 498 and the international average was 496. Figure 3 shows the PISA reading literacy scale in Massachusetts public schools compared with other participating education systems in 2012. (NCES, n.d.-b)

Education systems higher than Massachusetts	
Shanghai-China	*Macao-China*
Singapore	Japan
Hong Kong-China	*Liechtenstein*
Chinese Taipei	Switzerland
Korea, Republic of	
Education systems not measurably different from Massachusetts	
Netherlands	*Vietnam*
Estonia	*Connecticut*
Finland	Austria
Canada	Australia
Poland	Ireland
Belgium	Slovenia
Germany	
Education systems lower than Massachusetts	
Denmark	*Serbia, Republic of*
New Zealand	Turkey
Czech Republic	*Romania*
France	*Cyprus*
OECD average	*Bulgaria*
United Kingdom	*United Arab Emirates*
Iceland	*Kazakhstan*
Latvia	*Thailand*
Luxembourg	Chile
Norway	*Malaysia*
Portugal	Mexico
Italy	*Montenegro, Republic of*
Spain	*Uruguay*
Russian Federation	*Costa Rica*
Slovak Republic	*Albania*
United States	*Brazil*
Lithuania	*Argentina*
Sweden	*Tunisia*
Hungary	*Jordan*
Croatia	*Colombia*
Florida	*Qatar*
Israel	*Indonesia*
Greece	*Peru*

Figure 1: PISA mathematics literacy scale in Massachusetts public schools compared with other participating education systems in 2012. (NCES, n.d.-b)

Education systems higher than Massachusetts	
Shanghai-China	Japan
Hong Kong-China	Finland
Singapore	Estonia
Education systems not measurably different from Massachusetts	
Korea, Republic of	Ireland
Vietnam	Australia
Poland	*Connecticut*
Canada	*Macao-China*
Liechtenstein	New Zealand
Germany	Switzerland
Chinese Taipei	United Kingdom
Netherlands	
Education systems lower than Massachusetts	
Slovenia	Turkey
Czech Republic	*United Arab Emirates*
Austria	*Bulgaria*
Belgium	Chile
Latvia	*Serbia, Republic of*
OECD average	*Thailand*
France	*Romania*
Denmark	*Cyprus*
United States	*Costa Rica*
Spain	*Kazakhstan*
Lithuania	*Malaysia*
Norway	*Uruguay*
Hungary	Mexico
Italy	*Montenegro, Republic of*
Croatia	*Jordan*
Luxembourg	*Argentina*
Portugal	*Brazil*
Russian Federation	*Colombia*
Florida	*Tunisia*
Sweden	*Albania*
Iceland	*Qatar*
Slovak Republic	*Indonesia*
Israel	*Peru*
Greece	

Figure 2: PISA science literacy scale in Massachusetts public schools compared with other participating education systems in 2012. (NCES, n.d.-b)

Education systems higher than Massachusetts	
Shanghai-China	*Singapore*
Hong Kong-China	
Education systems not measurably different from Massachusetts	
Japan	*Chinese Taipei*
Korea, Republic of	*Connecticut*
Finland	Poland
Ireland	Estonia
Canada	*Liechtenstein*
Education systems lower than Massachusetts	
New Zealand	*Lithuania*
Australia	Greece
Netherlands	Turkey
Switzerland	*Russian Federation*
Macao-China	Slovak Republic
Belgium	*Cyprus*
Vietnam	*Serbia, Republic of*
Germany	*United Arab Emirates*
France	Chile
Norway	*Thailand*
United Kingdom	*Costa Rica*
United States	*Romania*
OECD average	*Bulgaria*
Denmark	Mexico
Czech Republic	*Montenegro, Republic of*
Florida	*Uruguay*
Italy	*Brazil*
Austria	*Tunisia*
Latvia	*Colombia*
Hungary	*Jordan*
Spain	*Malaysia*
Luxembourg	*Indonesia*
Portugal	*Argentina*
Israel	*Albania*
Croatia	*Kazakhstan*
Sweden	*Qatar*
Iceland	*Peru*
Slovenia	

Figure 3: PISA reading literacy scale in Massachusetts public schools compared with other participating education systems in 2012. (NCES, n.d.-b)

Forest Grove Middle School

Forest Grove Middle School (FGMS) is part of the Worcester Public School System. The Worcester Public School District serves 25,479 students in 45 schools as of the 2016-2017 school year. In the district, there is a diverse population of students, in terms of both race, ethnicity and students with different needs called selected populations. Race and ethnicity distribution throughout the district can be seen in Figure 4, with the highest population of students being of Hispanic descent (41.8%), followed by white (31.1%), African American (15.4%), Asian (7.4%), multi-race, non-Hispanic (4.1%), and finally Native American (0.2%). Worcester is also very diverse in selected populations. Figure 5 shows the percent of students whose first language is not English (53.5%), English language learners (34.2%), students with disabilities (18.8%), high needs (76.3%), and economically disadvantaged (57.2%). (Massachusetts Department of Elementary and Secondary Education [MDESE], n.d.-b)

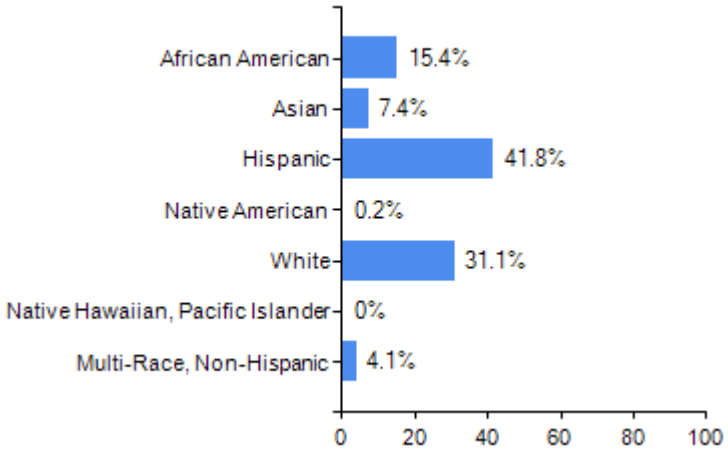

Figure 4: Student Race and Ethnicity Diversity in Worcester Public Schools (MDESE, n.d.-b)

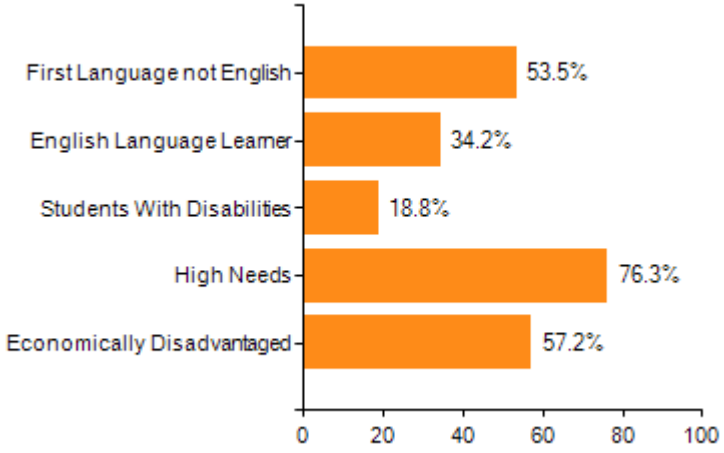

Figure 5: Selected Populations in Worcester Public Schools (MDESE, n.d.-b)

Similarly to the diversity that is throughout the Worcester School District, FGMS is an extremely diverse school. The population of the school consists of 12.5% African Americans, 5.1% Asian, 35.4% Hispanic, 42.1% white, .1% Native American, and 4.8% multi-race, non-Hispanic. FGMS also consists of a large population of selected populations. 42.8% of the students at FGMS first language is not English, 21.6% of students are ELL, 17.6% of student have disabilities, 64.1% of students have high needs, and 48.5% of the students at FGMS are economically disadvantaged. (MDESE, n.d.-a)

Districts and schools in Massachusetts are assigned a level 1-5 to measure the proficiency gap of that school or district. Assigning schools and districts a level helps districts determine which schools need the most assistance and helps the state determine which districts need the most support. Level 1 districts are assigned to those who have schools that meet the proficiency gap-narrowing goals, whereas the lowest performing schools are assigned to level 4 or 5. A district is

assigned a level based on the level of its lowest performing school. As a whole, the Worcester Public School District is considered a level 4 district. This means that there are one or more schools in the district that are classified as a level 4 school. However, FGMS is classified as a level 2 school. A level 2 school is one that does not meet the cumulative Progress and Performance Index for all students. A school can also be classified as a level 2 if it has low assessment participation rates for any group, specifically this can be between 90 and 94 percent. (MDESE, n.d.-c)

In 2016, a Composite Performance Index (CPI) score was given to all schools throughout Massachusetts. CPI is a number from 1-100 that represents the extent to which all students are progressing towards proficiency in a subject. This number is based off of MCAS or PARCC (Partnership for Assessment of Readiness for College and Careers) scores. ELA, math, and science CPI scores were given to all middle schools throughout Massachusetts. The schools can then be used to compare FGMS to other schools in the district as well as schools throughout the state. Students at FGMS received a CPI score relatively better than other middle schools throughout the district, however, they received a relatively worse score compared to the other middle schools throughout all of Massachusetts. Figure 6 shows this data from 2013 to 2016. (MDESE, n.d.-a)

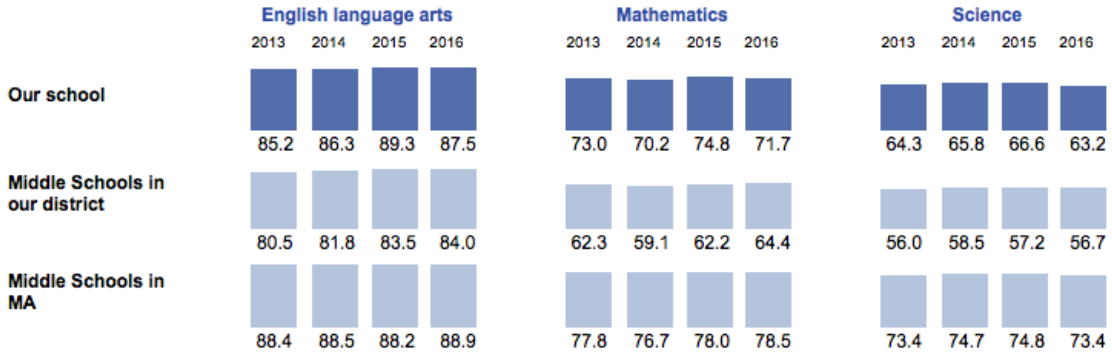

Figure 6: Comparative CPI scores for FGMS for other middle schools from 2013-2017 (MDESE, n.d.-a)

In 2017, math and ELA MCAS were given to 8th grade students at FGMS. Students scored an average scaled score of 491.9 on the ELA MCAS. This resulted in 3 percent of students exceeding expectation, 31 percent meeting the expectations, 50 percent partially meeting expectations and 15 percent of students not meeting the expectation. This can be compared to the state's overall ELA MCAS scores for 8th grade students. Throughout the state, 8 percent of students exceeded expectations, 41 percent met the expectations, 39 percent partially met the expectations, and 11 percent did not meet the expectation (see Figure 7). (MDESE, n.d.-b)

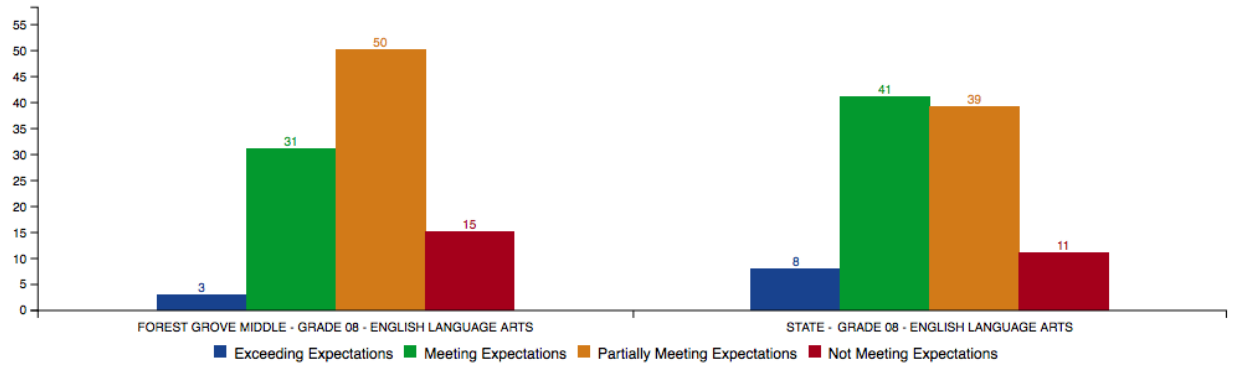

Figure 7: ELA MCAS Score for FGMS compared to the state (MDESE, n.d.-b)

Math MCAS were also given to 8th grade students in 2017. The average scaled score for students at FGMS was 494.1. This resulted in 5 percent of students exceeding expectations, 31 percent meeting expectations, 51 percent partially meeting expectations, and 14 percent of student not meeting expectations. These results can be compared to the MCAS scores of the overall state. Across the state, 9 percent of students exceeding expectations, 39 percent met the expectations, 42 percent partially met the expectations, and 11 percent of students did not met the expectations (see Figure 8). (MDESE, n.d.-b)

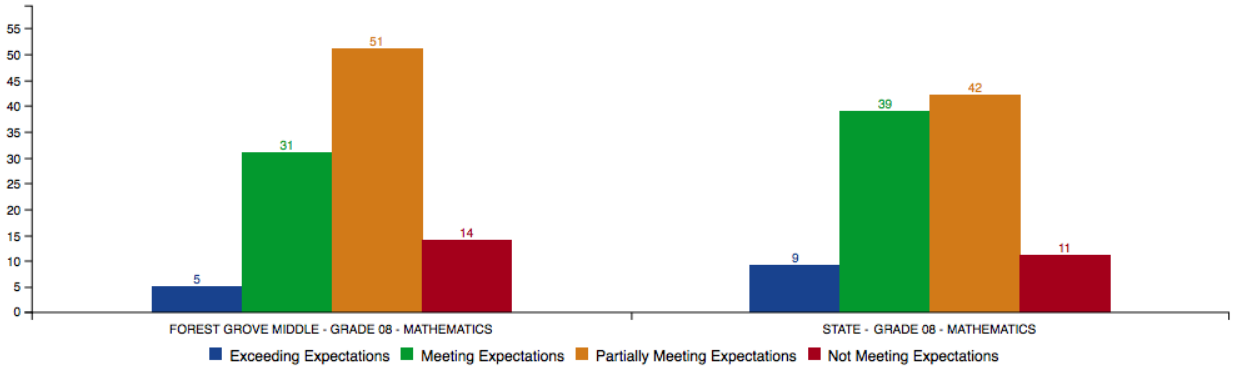

Figure 8: Math MCAS Scores for FGMS compared to the state (MDESE, n.d.-b)

My Classes

During my teaching practicum, I will be teaching four 8th grade level science classes. Of these, two are considered honors classes, one is an AVID (Advancement Via Individual Determination) class, and the fourth class is a college level class. The classes are labeled by color. The first honors class is called the red class which consists of 34 students; 14 females and 20 males. Among the class there are also two students with IEPs, three students with 504 plans, and three students who are transitioning ELL students. In this case two students have a level 6 EPL status and one student has a level 5. The second of the two honors classes is called the yellow class. This class has 32 students of whom 15 are female and 17 are male. Among the students, three have a 504 plan and one student is a transitioning ELL student at a level 6 EPL. The third class I have is the AVID class. AVID is a group of students who are often first generation college students. The goal of AVID is to help students become college and career ready. Extra help in math and literacy is provided for these students as well as a specific class to help the students with different school skills like organization and note taking. The AVID class consists of 28 students of whom 14 are female and 14 are male. In this class, three students have IEPs, three students have 504 plans, and ten students are ELL learners. Of the ELL students, four students have been withdrawn by their parents from ELL services and six students are transitioning ELL students. The transitioning ELL students consist of three students at a level 5 EPL and three students at a level 6 EPL. The fourth class I taught was called the green class. This class is made up of 16 students at the college level. The class consists of 5 females and 11 males. Of the class, four students have IEPs, one student has a 504 plan, and there are three ELL students. Of the ELL students, two have been withdrawn from services by their parents and one is a level 5 transitioning student.

Curriculum Guidelines

In 2016, the Massachusetts Department of Elementary and Secondary Education updated its curriculum framework for Science, Technology, and Engineering (STE) from the previous standards made in 2006. The goal of the new standards is to "emphasize the need for student engagement, relevance, rigor, and coherence in curriculum and instruction." (MDESE, 2016) With this in mind, the standards were set to focus on six ideas:

- Focus on conceptual understanding and application of concepts.
- Integrate disciplinary core ideas and practices to reflect the discipline of science.
- Present coherent progressions of STE core ideas and practices from pre-K to high school.
- Include each discipline in grade-level standards pre-K to grade 8.
- Contribute to preparation for post-secondary success in college and careers.
- Coordinate with the English Language Arts (ELA) and Mathematics standards.

(MDESE, 2016)

The 2016 standards have most of the same content as the old standards, however contributions made by many educators were used to update them. Most schools throughout the state have adapted to the new standards. However, the 2018 MCAS will not be guided by the new standards. With this in mind, the 8th grade curriculum at FGMS is still being taught based on the old standards. (MDESE, 2016)

For my classes in particular, though they are broken up into honors, AVID, and college level students, all classes are taught the same curriculum. The 8th grade curriculum consists of living environment and biology topics. Personally, I will be teaching the students about genetics, technologies, and then review of information for the MCAS. At the end of my practicum, my students will be taking the science and technology MCAS. Genetics is one of the last main topics they need to learn before taking the MCAS. The three genetics standards I will be teaching to my classes are: 1) Recognize that every organism requires a set of information that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another. 2) Recognize that heredity information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes. 3) Compare sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell). After teaching genetics, I will then go into teaching different technologies, Examples of standards that will be guiding this unit will be 1) Demonstrate methods of representing solutions to a design problem. 2) Identify and compare examples of transportation systems and devices that operate on or in each of the following: land, air, water, and space. After teaching about technologies, review for the MCAS will begin in class. Review will go over all

information that the students have learned in 7th and 8th grade. (J. McDermott, personal communication, January 10, 2018)

Chapter 2: Well-Structured Lessons

Candidate Assessment of Performance (CAP) is used to assess teacher candidate's readiness to take control of a classroom. CAP assesses the teacher candidate in relation to the Professional Standards for Teachers and parallels the Massachusetts Educator Evaluation system. The purpose of CAP is to better prepare teacher candidates and make sure that candidates are ready to be an effective teacher starting day 1 of their career. Teacher candidates are measured on a range of key indicators that is outlined by the Guidelines for Professional Standards for Teachers. The range that teacher candidates are evaluated on consists of 6 elements: 1) Well- Structured Lessons 2) Adjustment to Practice 3) Meeting Diverse Needs 4) Safe Learning Environment 5) High Expectations and 6) Reflective Practice. Teacher candidates must receive a status of proficient in all quality of all 6 elements in order to be considered "ready to teach".

A perfect lesson is one that is accessible to all learners, engages all students, and gets through the content while also showing students the joy of learning. The second CAP element is explicit to creating a perfect lesson. This element is titled "Well-Structured Lessons" and its role is to ensure that teacher candidates can efficiently create a lesson that captivates all students. According to the CAP requirements, an educator is deemed proficient in creating well-structured lessons if one

> "develops well-structured and highly engaging lessons with challenging, measurable objectives and appropriate student engagement strategies, pacing, sequence, activities, materials, resources, technologies, and grouping to attend to every student's needs." (DESE CAP, 2017)

A well-structured lesson greatly impacts student understanding as it will break information down into manageable chunks that is not overwhelming to the student. At the same time, a well-structured lesson will be able to connect the small subject matter to the overall picture of the unit being taught.

Personally, in order to make sure that every lesson I taught was effective, well-structured, and reached this CAP element, I made sure to come into the lesson with a well-thought out lesson plan. Lesson planning is essential to the creation of a well-structured lesson. There are many different parts to a lesson plan including what standard is being taught, clear content objectives and essential questions, language objectives for ELL students, modifications, and accommodations, as well as a blueprint for the learning activities that will occur in the class and a clear application to a student's life. Having a specific plan for what needs to be accomplished during a lesson makes teaching less overwhelming and ensures that all aspects to a lesson and subject are taught.

The different parts of a lesson plan are all uniquely important and as I progressed in my student teaching I began to see the importance of each and every part. Content standards were created by the Massachusetts Department of Elementary and Secondary Education and are used to guide educators in teaching what will be assessed on the MCAS. Content objectives, essential

question, learning activities, and application are all used to help guide the teaching of the standard. Language objectives, modifications, and accommodations are all in place to give extra support to students. This way, all student, no matter the learning or language disability, can access the curriculum.

With the help of a well thought out lesson plan template, each lesson I taught had a specific flow or routine. Routines helped students to stay on tasks and know what was expected of them. Specifically, all of my lessons began with a Bell Work. Bell Work was used in one of two ways, either to go over information that was taught the day before, or as an introduction of information that would be taught in class. Examples of different Bell Works I created were:

- Name and describe each of the 3 stages of the cell cycle.
- If a King Crab has 104 pairs of chromosomes, what is the diploid number and haploid number?
- Draw a pedigree that represents Mary married to Greg and with 2 sons (Scott and Tyler) and 1 daughter (Karen). Please label the pedigree with the names of the people.

Students were given a Bell Work sheet once every two weeks. The sheet was made for students to write the Bell Work along with their answer to it. If students did not know the answer it was their responsibility to write down the correct answer after we went over it as a class. Bell Work sheets were graded and an example of a student's Bell Work can be seen in Appendix A

After Bell Work, my lessons normally consisted of different learning activities. Learning activities involved various worksheets to be done individually or within their tables. Depending on the activity, I would often go through the process of "I do, we do, you do". This process is a way to scaffold learning for students. I would do the first problem on my own, doing a think aloud, explaining my thought process. As a class we would then do the next problem, I would often cold call students about the different steps to problem. Finally, students would work on the rest of the worksheet by themselves. I would walk around the classroom, checking in on students and helping those who were stuck. After a majority, if not all, students finished the activity, we would then go over it as a class. I would often go from table to table asking for volunteers, while also randomly calling on students. This ensured all students would be paying attention and would participate. Examples of different learning activities we did throughout the practicum can be seen in Appendix B.

After the class had finished the learning activities for the day, I would have students pack up their materials and sit quietly at their desks. Something I had to work on as an educator was having a wrap up to the lesson. At the beginning of the practicum, I would just wait for students to be seated quietly in their desks at the end of period. After giving a survey to my students, they pointed out that I was not clearly concluding what had been taught in the lesson. So, while students sat quietly at their tables I would give about a minute long speech just going over the key points of the day.

Fitting in all the needed content students must know into hour long periods is a difficult task to take over. Lesson planning helps to ensure that not only content is reached but that specific modifications and accommodations are also accounted for. The use of lesson planning was how I was able to make well-structured lessons. Examples of different types of lesson plans I created throughout the practicum can be seen in Appendix C.

Chapter 3: Adjustment to Practice

To adjust means "to change something so that it fits, corresponds or conforms; adapt" (Adjust, n.d.). An effective teacher is able to evaluate his/her class, identify shortcomings or areas that students are struggling in and then adjust a lesson to best fit the needs of the students. Just as creating lesson plans with correct modifications and accommodations for students is important, an adjustment of a lesson, especially on the fly is a key characteristic that teachers should be proficient in. The ability to adjust one's lesson is so important that it is a CAP element. A teacher who is proficient in adjustment to practice is

> "organized and analyzes results from a variety of assessments to determine progress towards intended outcomes and uses these findings to adjust practice and identify and/or implement appropriate differentiated interventions and enhancements for students."
>
> (DESE CAP, 2017)

There are three types of assessments that teachers can give out in order to gauge student understanding and then adjust their lessons to best fit his/her students. The first type of assessment is a diagnostic assessment. Diagnostic assessments are often pre-assessments to see student's prior knowledge. In my classroom, the bell work was a tool used as a diagnostic test for my students. When approaching a new topic, the bell work to start off the lesson would often be something that I had not taught the students yet. It was the student's job to recall from their prior science classes information on the topic. This was a great way to see, going in to a unit, how much student did or did not know, thus, giving me an indication of how much depth I would need to go into. An example of this was during the start of our mitosis unit. One of the first bell works of the unit was, "Name and describe the three stages of the cell cycle". Many of the students didn't know the answer to this, granted I taught it yet. However, this gave me an assessment of where student's prior knowledge was on the subject. Knowing most of the students didn't know the answer, meant I would have to start at the very basics, square one, on teaching mitosis.

The second type of assessment that a teacher can use to gauge student understanding is formative assessment. Formative assessments are used to specifically measure student learning while that learning is taking place. It is a way to measure student progress as well as instructor progress. Different forms of formative assessment include observations during in-class activities, formal or informal questioning, homework, and one-on-one conferencing. The majority of my assessments in my classes were formative assessments.

Specifically, I implemented walk around observations. A major part of my lessons consisted of different types of worksheets. In a normal class period, I would go over the instructions to the worksheet as a class, do an example problem with the students, explicitly state my expectations for what the students should be doing with the worksheet or activity, and then allow the students to work independently or with the students at their table to complete the activity. Once everyone had finished, I would then go over the answers to the worksheet as a class, often times cold-calling on different students, or going from table to table to make sure all students were paying attention and participating. While students worked on activities or worksheets independently, I would go around the classroom and check in on students. I would sometimes notice that some students would be struggling with the same question. This meant that I hadn't fully gone over a

topic or concept and that it needed more review. Knowing this I would adjust my lesson plan to stop the class and go over this topic.

I did this specifically when doing an activity on pedigrees. Prior to this lesson, I had already spent weeks going over dominant, recessive, and sex-linked traits. However, when we did a pedigree (family tree of traits) lesson, many students had become confused on important key information. Specifically, students had thought that if a trait was more abundant in a population then that meant that the trait was dominant. However, this is not the case. Many students were answering the question, "There are no carriers for Huntington's Disease- you either have it or you don't. With this in mind, is Huntington's disease caused by a dominant or recessive trait?" incorrect. They were looking at the pedigree seeing that there were less individuals with Huntington's disease in the pedigree and then stating that Huntington's was a recessive trait. This question can be seen in Appendix D. After noticing multiple students doing this, I stopped the class from working, and addressed the problem. I went over what dominant and recessive meant, being sure to be explicit that they do not mean abundance. I then used Denmark, a country populated with blond hair and blue eyed people, as an example of an area where recessive traits controlled the population. Giving this real life example, helped students to greater understand dominant and recessive traits, and answer the question on the worksheet correctly. This assessment also brought me to realize I must be very explicit with the definitions and examples I use. Making sure to repeat them over and over again until it's drilled into the students' heads.

The third type of assessment is summative assessments. Summative assessments are used to provide information and feedback that sums up the teaching. Usually when a summative assessment is given out there is no more formal learning taking place. These assessments are mainly used to see if content was taught and students retained information. In my class, summative assessments included quizzes. Throughout the practicum, I gave multiple quizzes, including one on genetics, one on codominance, incomplete dominance and sex-linked traits, and one on chromosomes. On all of these quizzes, students scored fairly well. There were some students that failed the quiz but when looking at a majority of the grades, most students passed. Since most students scored well, this implied that content was taught and students understood and reached the standards. Examples of all three of quizzes can be seen in Appendix E.

Unit exams can also be used as a summative assessment. They are a good indication of how students understood the material taught, however, by the time a unit test, or any summative assessment, is given out it is often too late. Implementing performance or formative assessments throughout every lesson is key to fully understand if students are grasping concepts. A quick walk around the classroom as students do a worksheet can be a way to assess students. A teacher can see if students are understanding concepts, and individually help those that can't. If a large majority of students are then continuously asking the same question or struggling with a certain topic, that is an indication that the concept needs overview and there should be a change in the lesson to go over this topic more thoroughly.

A major advantage of working at FGMS is that all student are taught the same curriculum. This made it so adjustments to a lesson could be done throughout the day. Since each class is taught the same lesson, problems that arise in the first period of teaching can be adjusted for in classes taught later in the day. Student shortcomings, confusion of instructions, or even whole topics that students did not understand can be recognized in the first lesson and then changed and adjusted for the rest of the periods taught. The first period of teaching a lesson can help discover the pitfalls of the lesson. Adjustments like chunking of directions, adding pictures or extra

explanation, and changing transitions in a class can be done from period to period. A lesson taught at the end of the day will be a perfect lesson compared to that taught in the beginning of the day, every mishap will be accounted for and at this point a lesson should fully be adjusted for all students.

Chapter 4: Meeting Diverse Needs

Diversity is defined as "the condition of having or being composed of different elements; variety; especially: the inclusion of different types of people in a group or organization." (Diversity, n.d.) The Worcester Public School District is a great example of a system with extreme diversity. As seen in chapter 1, Figure 4, Worcester is filled with students from all different ethnic backgrounds, including, Hispanic, white, African American, Asian, and other. Along with different ethnic backgrounds, every student is unique in their learning style, including any hindrance they may have. Hindrances may include learning and language disabilities. It is the job of the educator to be able to teach all students, no matter the obstacles they face. Being able to create lessons that individually meets the needs of all students is one of the six CAP elements a teacher candidate must be proficient in. Formally, this CAP element is called meeting diverse needs, and to be deemed proficient in it a teacher candidates

"uses appropriate practices, including tiered instruction and scaffolds, to accommodate differences in learning styles, needs, interests, and levels of readiness, including those of students with disabilities and English learners." (DESE CAP, 2017)

To be prepared to teach all students, lesson plans include three main sections in which teachers can specifically aim to scaffold a lesson for his/her students. These sections include modifications, accommodations, and language objectives.

Modifications are adjustments to the learning for student, specifically it is changing what students are learning in the classroom. Students who receive modifications are not expected to learn the same material as their classmates. Modifications are often used for students that are far behind their peers and cannot successfully comprehend content at grade level. An example of a modification for a student is giving a student shorter or easier reading assignments or even alternating tests and assignments. For example, if a class is given a spelling test with 20 words, a student with modifications may have a test with just 10 of the 20 words, or perhaps the words could be completely different. Modifications are unique in that students with modifications are expected to learn content, however, they are not expected to learn the exact same content as their peers. Personally, during my practicum, none of my students needed modifications. All students were able to access the curriculum at grade level, however, some students had more difficulties then others. For these students, accommodations were set in place (Strom, n.d.).

Unlike a modification in which there is an alteration to what the student is learning, an accommodation is an alteration to how the student is learning. Students with accommodations are still expected to learn the same content, but the methods a teacher uses to make the curriculum assessable will be different. For example, an accommodation may be giving a student preferred seating so they can focus more, or making the text on worksheets bigger for a student with impaired eyesight.

Throughout my practicum there were many different accommodations I had to make for my students. These accommodations mainly came from instruction on students IEPs. IEP stands for individualized education program and is a legal document that spells out a student's learning needs, what the school will provide, and how progress of the student will be measured. IEPs are used to address a student's unique learning issues and then provide specific educational goals for the students. Within my classes I had a total of eight students with an IEP. Common accommodations on my students IEPs were extended time on assignments, repetition of directions or phrases, and using verbal or visual cues. Knowing that my students needed these accommodations to be successful, I ensured to implement the proper accommodations for all of my students in every one of my classes. Specifically, when given an activity, quiz, or assignment, students with an IEP was given as much time as needed to finish their work. Positive prompting to keep them on task was often needed, however, students were given as much time as they needed to process and do their work effectively. Repetition of directions was also a key focus I had in my classes. By being explicit with what I wanted my students to do as well as repeating directions multiple times before starting an assignment, I ensured that not only did my students with IEPs were accommodated for but that all of my students knew what was expected for each task as well.

The last section to a lesson plan that can help meet the needs of all students is titled language objectives. This section is specially used for English Language Learners (ELL). There are 6 levels to ELL students, ranging from no knowledge, level 1, to mastery, level 6. Along with these 6 levels, there are 4 language domains that include speaking, reading, writing, and listening. It is the responsibility of the educator to not only teach content, but progress a student in language skills and push them to a mastery level. There are certain techniques that can be used to guide students in language. One technique is the use of repetition, re-phrasing and restating. Another technique is the use of visuals as a way to get students to understand content. These strategy are used to not just push content but also help student practice a language domain and become more efficient in the language.

Specifically, I had seventeen ELL students with in my classes, however, by the time I took over the classroom a majority the ELL students I had were either a level 5 or 6. This meant that they were considered to be at a very high if not mastery level in English. Though this was the case for most of my ELL students, I did have six students that were low in English comprehension. Most of these students had been withdrawn from ELL services, however, they still needed language scaffolding. With this in mind, I made sure to use different language techniques with in my classes to help the students not only understand the English language better but also understand the content better. Particular techniques I used in my classroom to help guide the language domain was the use of visuals. Not only showing pictures but also having the students draw pictures of different vocabulary we were learning was a great technique for ELL students to put an image to a word. An example of the use of visuals can be seen in Appendix F. As a part of a lab on mitosis, students had to create the different phases of the cell cycle out of Oreos and sprinkles. After completing this task, students then had to draw each phases in a chart

and include labels. By each students, specifically my ELL students, personally drawing a picture and labeling it, they could put an image to the exact vocabulary we were using in class. An important idea to take note of about science is that it is full of vocabulary. Each unit I taught had multiple vocabulary words that all of my students, not just ELL, did not know. Knowing this, each unit had an introduction vocabulary lesson, in which students would create a cover sheet and a flipbook on the new vocabulary. This not only helped ELL students get a glimpse of the new vocabulary that was to be used but it also provided all of my students with an introduction to the vocabulary. Appendix G gives an example of a student's cover sheet and flipbook.

Along with the use of visuals, I found the technique of repetition, re-phrasing and re-stating as a vital technique to help my ELL students' progress in the content and in English as a language. Constantly repeating vocabulary helps students to become more comfortable with it. The more the students hear the vocabulary the more likely they are to remember what it means. The use of re-phrasing and re-stating was also vital to the progression of ELL students in my classroom. By asking for synonyms to words or putting vocabulary into my or my students own words, students could greater grasp what the vocabulary meant. Although most of my repetition, re-phrasing, and re-stating was done on the fly in the classroom, I made sure to have these techniques as a part of my lesson planning. I made sure to repeat vocabulary in every question or discussion we had. My supervising teacher, Ms. McDermott, was very adamant on the fact of always using content and scientific vocabulary. For example, when doing a lab on making DNA out of Twizzlers and gummy bear, it was important to say what the gummy bears and Twizzlers represented, but once that was clearly stated the two shouldn't be referred to as candy, but rather by the parts of the DNA they were representing. Gummy bears represented adenine, thymine, cytosine, and guanine and should be used in such a way. The Twizzlers represented the backbone of the DNA molecule and should be referred to as that. By implementing and repeating the vocabulary in even a simple lab activity, the expose to the new words, can be used to help ELL students become comfortable with the vocabulary, helping them to progress in the English language. An example of this lab activity can be seen in Appendix H.

Chapter 5: Safe Learning Environment

In order for a student to thrive in the classroom, one must feel comfortable and safe to take risks in the content area. To push students to their fullest potential, a classroom must be deemed as a secure place, where students aren't afraid to take risks, question the content, and enhance their learning. For these reasons, creating a safe learning environment is one of the essential CAP elements for teacher candidates. In order to reach a proficient level of creating a safe learning environment a teacher candidate

> "Uses rituals, routines, and proactive responses that create and maintain a safe physical and intellectual environment where students take academic risks and play an active role— individually and collectively—in preventing behaviors that interfere with learning. Is able to model this element." (DESE CAP, 2017)

A safe learning environment is established through rituals and routines in the classroom. Rituals and routines help to do two things. First, they help to increase instructional time. Second, they create a sense of comfortability in the classroom. Rituals and routines are vital to the creation of a safe learning environment within the classroom.

Teaching at the middle school level is about getting the most out of your students during the short period you have them for. At FGMS, each period is about an hour long. That being said, it is vital to maximize the about of instructional time in the period. Rituals help to do such a thing. They reduce the time that students aren't working on school work. For example, in my classroom, each table has a crate where their science binder is kept. Each day one student from every table is assigned to get the binders for the rest of the table and another student is assigned to put away everyone's binders. This ritual minimizes the number of students out of their seats as well as how long they are out of their seat for, thus maximizing the learning time in the classroom. A picture of the crate can be seen in Appendix K. Another routine that I personally established in my classes came towards the end of the each period. When it was time to wrap up the lesson and for students to put their binders away I would say the following phrases, "I need three things to occur before anyone can leave this class. Binders must go away, everyone must be seated, and everyone must be silent. Once I have these three tasks complete, and the bell rings, I will let you leave." I said this almost every day to all my class and unless every student was seated and quiet, no student would leave the classroom. This helped to establish a more organized classroom, in which at the end of the period students would be able to calm down for a minute, while seated quietly before moving on to their next class. A major positive to this technique was that students would discipline themselves. If certain students were not sitting down and being quiet, the other students would tell them to do so knowing that they would be allowed to leave until all were seated and quiet.

Besides rituals, the establishment of routines is a vital technique that facilitates a safe learning environment. Routines create stability within a classroom, increasing both learning and student achievement. My classroom thrived off of routines. Every class would begin with a Bell Work. This would allow students to transition into the mind of science. If homework was given the night before I would then check the homework and we would go over it as a class. Next, we would do various activities. Activities either included worksheets, a reading, or a lecture. Often times, classwork consisted of different worksheets. However, no matter the worksheet, the same routine went along with it. I would instruct the students on how to do the worksheet, giving them background and asking them various questions about what we had learned. Then students would work on their own or in groups to complete the worksheet. Finally, to wrap up the lesson, we would go over the worksheet as a class. This clear routine made students feel more comfortable in my classroom, as they knew what do expect each day. The establishment of routines helped my students to thrive.

Another way in which I created a safe learning environment in my classroom was by always being positive. Specifically, when students go a question wrong in class I was always say “Great job!” or “Good try.” and then try to guide them to the correct answer. Students also understood that it was okay to make mistakes with in my classroom. To demonstrate this, I made sure that when I made a mistake in my instruction, that I would then admit my mistake, fix it, and show the students that it was fine that my mistake occurred. I would often thank a student for pointing out my mistake. Throughout my practicum, I believed I was demonstrating that mistakes were okay, however it wasn’t till I gave out a survey to all of my classes that I could confirm that I was actually doing. One of the questions on the survey stated, “My teacher demonstrates that mistakes are a part of learning”. In this category most of students said they strongly agreed or agreed with this statement. This feedback gave me confidence that I was creating a safe learning environment within my classroom.

Chapter 6: High Expectations

Self-fulfilling prophecy is “when a person unknowingly causes a prediction to come true, due to the simple fact that he or she expects it to come true.” (Self-fulfilling prophecy, n.d.) In other words, an expectation about a person can affect that person's behavior which in turn will cause the behavior to happen. Self-fulfilling prophecy is directly applicable to the classroom, the expectations that a teacher sets for her students, will either drive her students to success or leave a student not reaching their full potential. For example, if a teacher was to set low expectations for their students, then students will likely perform poorly. Students will not think that they can do more than the low expectation set for them. This is known as the Golem effect. The Golem effect “describes the process where superiors (such as teachers or managers) anticipate low performance from subordinate, causing the very behavior they predict.” (Brescia, 2017)

On the other hand, if a teacher is to set high expectations for their students, students will perform at a high level. This is known as the Pygmalion effect. The Pygmalion effect is when “a superior’s raised expectations of subordinates actually improves performance”. Creating high expectations for a student will ultimately push them to their full potential, advancing the students in areas they initially thought they couldn’t reach. It is important to note that expectations for students should not change based on initial skill level. Since creating high expectations is so important to the success of a classroom it is considered one of the six CAP elements. According to the CAP rubric, a proficient teacher candidate in high expectations “effectively models and reinforces ways that students can master challenging material through effective effort, rather than having to depend on innate ability.”

Academic expectations were the same for all of my class, no matter if it was an honors, avid, or a college level class. All students were expected to learn the same material and at a high level. Specifically, the use of academic vocabulary was a high expectation in my classroom. For every unit, subunit, and lesson I taught, my students were expected to not just know the vocabulary for the subject, but understand the vocabulary and be able to use if effectively. For example, in my DNA unit, students couldn’t get away with just using the letters A, T, C, and G, for the nitrogen bases. Rather they were expected to know the actual names of the bases, adenine, thymine, cytosine, and guanine, and be able to use them in a sentence.

Academic vocabulary was just the tip of the iceberg as to the high expectations I set for my students. Students knew that all work that was done in class should be done to their best effort and should be completed within the class. If there was work not completely in class, students knew that it was to be completed for homework. Often, students would tell me they didn’t know the answer to a question or that it was too hard. However, I would not let students get away with this excuse. I would tell them that they knew the information and if anything to give their best guess. If necessary, I would give the students hints to the answer. Students knew the expectation was that they would at least try to answer my questions and that a response of “I don’t know” was not acceptable.

Throughout my practicum I was very explicit in my expectations for my students. Before starting any activity, I would tell my students exactly what I expected they do for the activity. Even if it was a simple worksheet I would tell my students, "I expect for you all to work independently and quietly in order to to complete this activity. We will then go over it as a class and I expect everyone to be able to and willing to participate." By being explicit in exactly what I wanted my students to complete, students knew what they needed to do within my class. By also announcing this to the class, students knew that the expectation was the same for all students, and that these expectations were high.

Not only were academic expectations high in my classroom but so were behavioral expectations. Behavioral expectations were set in place throughout the school through a STAR expectations poster, which can be seen in Appendix I. In FGMS, each classroom has a STAR expectations poster in it. STAR expectations is an acronym for four expectations that FGMS has for its students. S stands for Show respect, T stands for Take responsibility, A stands for Act appropriately, and R stands for be Ready to learn. Under each expectation is examples of just how students can demonstrate each action and be considered a STAR student. The STAR student expectations were not just seen on a poster but they were also transferable to my classroom. Students knew that respect was required in my classroom. Respect was not just deserving to me, but also to other classmates and faculty members. I made sure to treat all of my students with respect, in hopes to not just model what respect looks like but also show the students that if I respect them then I would want respect in return.

Expectations in both behavior and academics were extremely high within my classroom. The higher the expectations I created for my students, the further they achieved. The success of my students was directly related to the expectations that was set for them. By installing high expectations in my classroom and not letting students settle for anything less than my expectations, students achieved more, and a positive self-profiling prophecy was obtained for each student.

Chapter 7: Reflective Practice

A great educator is one who assists students, sculpting the next generation of people, and advancing students as both people and in knowledge. A great educator is also able to reflect on their practices to see what they can do differently to be more accessible to all students and ensure that lessons are done as effectively as possible. Reflection is defined as "a fixing of the thoughts on something; careful consideration." (Reflection, n.d.) A great educator is able to put significant thought in to what occurred in every lesson or every class, and see certain pitfalls or shortcomings to the lesson. He/she is then able to make adequate changes to the lesson or style of teaching to make sure that all students are being accounted for. In order to be considered proficient in the last CAP element, a teacher candidate much

"regularly reflect on the effectiveness of lessons, units, and interactions with students, both individually and with colleagues, and use insights gained to improve practice and student learning." (DESE CAP, 2017)

In my opinion, reflective practice is the most important CAP element. Reflecting on a lesson or a tactic of teaching can only help to improve one's teaching performance. There is always room to enhance one's practice, even veteran teachers can reflect on their work to better themselves. As a new teacher to the classroom, reflecting on my teaching performance was vital to my success in the classroom. Throughout my practicum I used reflection to ensure my students were getting the best version of me possible.

During my practicum I sought a majority of my feedback and reflection from my supervising practitioner, Jessica McDermott. Ms. McDermott gave me many different types of feedback, both for immediate fixes to a lesson and for teaching skills as a whole. An advantage to working at the middle school level is that all students are required to learn the same thing. Although there was tracking in FGMS, creating honors, avid, and college level classes, every class was taught the same material and was responsible for learning the same curriculum. That being said, I was able to teach the same lesson four times throughout the day. This gave me ample opportunity to see the pitfalls to a lesson in the beginning of the day and change the lesson around to then have a perfect lesson at the end of the day. Ms. McDermott was key in helping me not only find the early pitfalls to a lesson but also reflecting on my methods of teaching within an early lesson. Ms. McDermott gave me plenty of feedback throughout the practicum to help advance my teaching. A specific example of feedback from Ms. McDermott was to not allow student to get away with saying "I don't know". Students do know the information they just find it easier to say "I don't know". Giving students hints can help them out or even allowing a classmate to help them answer the question. However, the original student should always be brought back to, to check for their understanding. Another piece of advice Ms. McDermott had for me was to make sure to refer to worksheets and packets as activities or interactives. Worksheets and packets have a bad connotation and automatically make students uninterested in what the lesson is about. By

referring to work as an activity or interactive students are more likely to pay more attention and try their hardest on the activity. A final piece of reflection that Ms. McDermott gave to me was to constantly use academic vocabulary in my lessons. Nothing in science should be referred to as "thing" or anything besides the scientific vocabulary that the class was learning. As a teacher, the more I used the academic vocabulary the more likely the students would become comfortable with the words and use them as well.

As the practicum came to a close, I was able to reflect on my practice individually, with an outside perspective. I knew what a perfect lesson consisted of and if I had taught a lesson that was anything lesson then the perfect standard I would reflect on it to see how I could make it better. This act of self-reflection can specifically be seen when I did my introduction lesson to meiosis. This lesson consisted of a PowerPoint, video, animation, and then worksheet. This can be seen in Appendix J. I had first done this lesson with the red honors class. Through the lesson I had students takes notes on the PowerPoint, then we watched the video and animation and discussed it. While doing the lesson I realized that by just talking about the animation I was not getting the correct information across to my students. Students could easily just zone me out and not obtain the correct information. After reflecting on the lesson, I decided to change how I taught the animation to the blue class. Instead of just discussing the animation, I had students create a note sheet on each phase to meiosis. This kept the students much more attentive and involved in the lesson, as well as it gave them clear notes that they could use for studying later on. I felt much more confident with my lesson after making these fixes, however it took reflection and honest with myself that my originally lesson was not the best lesson for the students.

About halfway through my practicum, I gave a survey to all of my students. I was able to gather information from the surveys, reflect on it, and change some of my teaching methods. An in depth analysis of the surveys will be done in a later section. Though many of the comments I received back from the surveys were positive there were some comments that made me rethink how I was teaching my students. One comment in particular was "In my opinion, you talk a bit fast. I'm not saying that's bad I'm a little slow and it would really help if you talk a little slower." With this comment in mind, I made sure to speak slower in my class, increase repetition that way if I did talk fast students had enough reiterations to understand me, as well as I made sure to do more frequent checks after I had lectured to make sure students understood the information. All in all, reflection on one's practice is vital to the success of any teacher, particularly a teacher candidate like myself.

Chapter 8: WPI Education

Worcester Polytechnic Institute (WPI) is known for many things including being one of the most prestigious institutes in the northeast, its motto of "Lehr und Kunst" (theory and practice) along with an emphasis on project based learning. Such ideas makes WPI a particularly unique educational system. I have had the privilege to attend WPI as an undergraduate student pursuing a bachelor's degree in mechanical engineering. Fortunately, WPI has not only set me up to seek a career in engineering but it has also given me the opportunity to pursue a career in education. WPI has provided me with vital skills that I was able to bring into the classroom as a teacher candidate.

Throughout my practicum I taught biology, as a mechanical engineering student, I have not taken many biology courses. However, the structure of classes at WPI greatly influenced how I taught my students. Many of my undergraduate classes consisted of group or project work. Not only was group work prominent in my classes, but it is one of the main ideas of WPI. WPI prides itself in its emphasis of collaboration and working together rather than students working against each other for particular grades. Being able to work in groups efficiently is a skill that must be learned. The earlier students are put into groups, the greater they will become at this skill. For this reason, WPI influenced the way I structured my classes to make sure students were given constant opportunities to work with one another.

Luckily, Ms. McDermott, had her classroom already set up into eight different groups. Each group consisting of two tables and four chairs. The lay out of the room can be seen in Appendix K. Since students were already placed in groups, it was my job to create lesson content in which students could take full advantage of their classmates' knowledge. For this reason, a majority of my lessons allowed students to work with each other at their tables to complete the tasks for the day, whether this a worksheet or lab activity. Just as WPI has taught me to become very comfortable working in groups, expressing my ideas, and listening to others, I was able to facilitate the same skills within my classroom.

Besides the structure of WPI, my school has also provided me with education courses that helped me prepare for many aspects of the classroom from how to be ready for the first day in the classroom to how to help ELL students. Specifically, ID 3100 or Teaching Methods in Math and Science was a seven week course were I learned the basics of teaching from lesson planning to an introduction to IEPs and 504s, as well as how to make accommodations for students. This course also had an observing component to it. Throughout the course we visited multiple classroom to see different teachers at work. This gave great insight to the many different teaching and classroom styles one can have. The next course that was vital to my success as a teacher candidate was ID 3200 or Sheltered English Immersion. This course was about how to approach ESL learners in the classroom. Worcester is a very diverse area and with diversity comes language barriers. This course gave me techniques on how to make ELL students comfortable in the classroom as well as different techniques on how to get both content and language across to these students. The last course that WPI offered and was integral to my

success in the classroom was PSY 2401 or The Psychology of Education. This course taught me about the cognitive development of adolescents and how educators can have a great influence on this development.

In conclusion, the courses provided at WPI, specifically the education classes, alongside with WPIs emphases of teamwork and project based learning greatly influenced my approach to teaching and was an ample component to my success in the classroom.

Chapter 9: My Classes

FGMS is ran in a very unique fashion. In 7th grade, students are placed in groups based on their specific math level. Each group is assigned a name; my cluster names were based off of colors, red, blue, green, and yellow. Students then travel from class to class with their assigned group, never switching who's in their class. As seen in FGMS, there was a direct correlation between higher level math groupings and students abilities in other subject matters. Since students remained in the same group of students for all classes, this created different level classes for all subjects. I had two honors level classes, one avid level class, and one college level class throughout my practicum. However, due to the 8th grade science MCAS, all students were expected to learn the same curriculum. Every one of my classes, no matter the level, was taught the same content in the same way. The content I taught came from the Massachusetts Department of Elementary and Secondary Education and was based off of biology standards, mainly genetics.

Red Class

The first class I took over was Ms. McDermott's homeroom class. This class was titled the Red class and contained 34 honors students. A majority of the students in the class were very focused and willing to do the work assigned to them. Though some students could be distracted and not open to do all the work, the positive attitudes of the other students influenced stragglers to get their act together and stay on task. I would consider this class the most productive of all my class and I was especially able to make strong connections with these students because they were also my homeroom class. Every morning, before first period would start, I was given 15 minutes to take attendance, assign school wide bell work, and talk with my students about how they were doing. The extra 15 minutes with my students gave me a great opportunity to make connections with them. These connections were especially helpful when having to deal with any behavioral behavior problems that would arise within the red class.

One concern I had with the red class was that there were five students on IEPs for classroom issues associated with Autism. Of the five students, three of them were very well behaved and maintained a great focus in class. They hardly needed any redirection and interacted well with the other students in the class. Of these three, two of them needed a little more time to complete tasks as they were slow in comprehension. To combat this, I made sure to place both students with very understanding peers who could help push them along in tasks. I also made sure to give these students as much time as they need to complete tasks, even if this meant they would have to take work home or come in during lunch to finish their work.

As for the other two students with Autism, their specific issues were more difficult to handle. One student was extremely distracted and would often yell out during the class. This student was very capable of doing his work, however it would take a lot of redirecting from myself in order to get him on task. At times he would even refuse to do work. To make sure I would get the most out of this student, I sat him in a group with very productive students, hoping the effective work of these students would rub off on him. For the most part this worked, with the help of the

students around him and some redirecting I was able to get great work out of this student and through assessments I knew he was retaining the information I was teaching in class.

The last student in the red class that was on an IEP for autism was also most severely affected by it. This student had an instructional assistant go with him from class to class. He had a very hard time picking up on social cues and would often get very flustered in class, especially when given a time limit. He was distracted easily and when redirected would either deny his lack of focus or be physically upset. Maintaining a positive attitude was vital to his success in the classroom. When having to redirect him, it was important for me to follow up with a work of encouragement, stating that I could see the work he had already done but that I knew he could be doing more. This student replied very well to this feedback and he helped to give me great insight in to how to treat students with differences.

All in all, the red class was a pleasure to teach. They were a very productive class that was normally always on task. They performed well on tasks including quizzes, labs, and different daily activity. This class was often a great gauge to see if students were understanding the content I was teaching. Not only did the red class challenge me to push them academically, considering the level of honors student in the class, but the different levels of students with IEPs in the class also gave me a great insight as how to handle students with different behavioral issues.

Green Class

The second class that I took over was the green class. The green class consisted of 16 college level students. This class was by far the hardest to teach. Besides the challenge of having many ELL students in the class, the behavior of this class was also far worse than any of the other classes. It was often hard to get through any lesson smoothly. Any little thing that would occur in the class would lead the class on a whirlwind, with multiple students speaking out of turn, commenting on anything and everything that had happened. Though most of the students in this class were more than capable of completing the same work as their classmates in other classes, most of the students had in their head that they were a part of the “dumb” class and they weren’t expected to be smart or complete any tasks. It was a constant struggle to get students to maintain focus and do their work. This was especially evident when students were supposed to do independent work. Unless I was over a student’s shoulder guiding them through every step, student would often not do their work. The students of this class wanted to be hand held through everything. When independent word was not successful in the class, I would try to do the work together as a class on the board. However, this often left students to just mindlessly copy down what I had written without thinking or attempting to learn any of the material.

The main reason the students of the green class made it extremely hard to get content across to them was because of their behavioral issues. Not only did students find it very hard to maintain focus and wanted to be handheld through all activities, the students were often very disrespectful. Students had very little respect for educators, making disciplining them very hard. When told that they were being disrespectful, students would normally apologize but continue with the same actions they were doing. Even a treat of lunch detention made little effect on the

students of this class. Eventually the green class became so hard to teach that Ms. McDermott began to co-teach the class with me. I was in charge of the content of the class whereas Ms. McDermott was responsible for disciplining the class. Though I would have loved to have full control of this class, the behavioral issues of this class required a veteran teacher. By co-teaching the class, I was more easily able to help students and I was able to teach the content in a more productive manner.

Just as the green class was extremely hard to teach, this class gave me a real look into what a classroom would look like in my future teaching profession. The class had many challenging students in it. Specifically, one girl in the class never liked to do her work and would often become very defensive and disrespectful when confronted about her work effort. This student was very smart when she applied herself to the work. On her good days, if I asked her a question she would know the answer and say it with confidence. However, on her bad days if I had asked her for an answer, she would often reply with "I didn't have my hand up! I'm not answering your question." On these days it was very hard to try to work with this student and my initial reaction was to just not call on her, letting her get away without participating. After speaking with my supervising teacher, I found some techniques on how to deal with this particular teacher. First, I was told not to allow her to get away with given attitude and not answering a question. Instead, I could warn this student that I was going to call on her for a particular question. This way she could be more prepared and willing to answer my questions. Another change I made for this student was I placed a positively influential student next to her in class. Immediately after moving the positive student next to her, there was a huge improvement in behavioral. The positive student helped to keep my problematic student on tasks and encouraged her to do work. Instead of an intimidating adult trying to get her to do work, her peer could influence her in a positive manner. Ultimately, with these changes, the student's behavior was much more constructive to the class.

The green class was a struggle to teach; I had to persevere through each class in hopes that the students of the class would behave well enough so I could get content across to them. Tips given to me by my supervising teacher greatly helped to improve the behavior of the class and I was able to get positive assessment results from these students. The green class was an eye opening experience to a difficult class I could face in this profession.

Blue Class

The third class I took over and by far my most enjoyable class to teach was the blue class. This class had 28 students in the AVID program. AVID stands for Advancement Via Individual Determination and is a program to help those normally underrepresented in higher education become college ready. Students in this program take an extra class that provide them with skills to help them succeed in the classroom. Most of the students in this class are first generation college students and/or ELL students.

This class had a unique personality. The students in this class were extremely talkative and eager to voice their opinions. It was often hard to get the class focused on a task, I had to constantly call out students for talking rather than doing their individual work. However, after a

few redirections the students of this class would get down to business and complete the tasks at hand. Specifically in this class, I used the idea of proximity to influence students to stay on task. Instead of lecturing at the front of the class I would stand in the middle of the classroom. This increased my presence towards the students. Students were less likely to be off task and talking if I was closer to them.

Out of all of my classes, the blue class had the most ELL students in it. For this reason, I had to use many techniques in order to get past the language barrier between me and my students. I would normally repeat myself multiple times, use synonyms or rephrase vocabulary, and use visuals to help my ELL students. I would also point out specific prefixes or suffixes to new vocabulary to try to give the ELL students another form of understanding. The biggest challenge in this class was the language barrier. Some students would just give up and say they didn't know the answer because the language was too hard. With this in mind, I made sure the students in my class had plenty of opportunity to ask questions on language without feeling ashamed of their confusion. I also made sure to do as much frontloading of vocabulary as possible to make sure all students in the class, not just ELL students, were exposed to the vocabulary, in hopes that they would feel more comfortable with it.

I definitely had the most fun teaching this class. Though they were very talkative, I had created the best connections with the students of this class. Students in this class were very comfortable with me as I was with them. We were often able to joke with one another, making each period high of energy and incredibly fun to teach. Though this class had moments of chaos, the connections I made with the students allowed me to easily get them back on track to complete their work. The blue class was the most entertaining class to teach and this class alone positively influenced my teacher candidate experience.

Yellow Class

The last class I took over was the yellow class. The yellow class had 32 honors students in the class. This class was fairly easy to teach, most students were self-motivated to do well in the class. Students rarely complained about the work they were given in class and they were eager to learn about genetics. However, one challenge I faced in this class was that some boys in the class were very talkative. I often had to redirect a group of boys to start their work or stay on task. The group of boys were very smart but their constant talk kept them distracted and they didn't learn the content as well as they could of. Also, my constantly redirecting them, time was taken away from other students in the class. Part of the reason why this group of boys were so distracted was they were all sitting at the same table together. In order to combat this, when I switched student's seats at the end of the third quarter I made sure to separate all of the boys. The further the group was from one another the less they could distract one another. After changing the students' seats, the class was run much more smoothly and there was less time taken out of class to redirect students and more time learning the content.

For the most part, this class was fairly easy to teach. Besides that talkative boys in the class, as a whole, the class stayed on task and did all the work that was assigned to them. However, there was one particularly challenging student in the class. This student either did one of two things on

a given day. He was either sleeping at his desk, or he was being very distracted, often times blurting out random words during a class. What was particularly challenging about this student was that he knew the content well and scored well on assessment. Nonetheless, his behavior was inappropriate for the classroom. To try to stop the talkative inappropriate behavior I would often have to talk sternly to the student, making sure he knew this was not appropriate. On the other hand, when the student was asleep, I would have to call upon him to wake him up and keep him focused. I decided to place him next to one of the smartest and productive students in the class. My class activities often required working in groups or pairs. By pairing these two students together, the productive student pushed the other to get his work done as well as to learn the content. This was extremely productive, my challenging student was now one of the first to finish the classwork. When I asked him questions on content, 9 times out of 10 he knew the correct answer. This partnership is a great example of how class seating and peer partnership can be vital to the success of a student.

The yellow class was a pleasure to teach during my practicum. Though there were some distractions, students and myself got the most out of the class. There weren't any major problems that came up within the class and ultimately this class proved to be a great teaching experience for myself.

Chapter 10: Student Feedback

Roughly halfway through my teaching practicum I was given the opportunity to survey my students with a series of questions that focused on the specific CAP elements. This survey was to be used to gauge what my students thought of teaching and it was an instrument to help me reflect on my work in the classroom. The survey can be seen in Appendix L. The survey was made of 20 questions and students could choose one of four answers per question, strongly agree, agree, disagree, and strongly disagree. Students were then given a space to write any comments they had about my teaching. For the most part, the comments I received were very encouraging. Students thought I was doing a great job as their teacher. Examples of comments include: "Keep up the work. I like this class more than I used to before. You changed my thoughts about this class.", "Ms. Nugent is a really great teacher, she has a very nice personality and she teaches very well. Her voice is clear and understandable. She helps us understand concepts and ideas by connecting them with things we do.", and "I love how you teach, whenever you teach in your own classroom you'll do perfect". These comments were a huge confidence booster. They gave me validation that I was doing a good job in the classroom.

Although the comments to the survey were very encouraging, the specific results to the survey gave me more of an insight of what students believed of my teaching. I took the results of the survey to reflect on my practice and change certain parts of my teaching. In order to analyze the surveys, I assigned each response with a number. Strongly agree was assigned a 4, agree a 3, disagree a 2, and strongly disagree a 1. I then averaged the results from each student's survey to give myself an overall score for each question. The closer the average score was to 4 the more strongly students agreed with statement. Likewise, the closer the score was to 0 the more likely students disagreed. After averaging out all of the questions, I looked at those that received the lowest score and tried to alter my practice to change how my students felt about these aspects to my teaching.

The question that received the lowest score was question 17, "Our class stays on task and does not waste time." This question received an average of 2.55. Prior to giving the survey out I expected that question to receive a low score. I often let my students talk while doing work. This was a double edged sword. Students could use this to collaborate and feed off of each other's ideas or they could become very distracted, talking about different events happening in their lives. The survey confirmed that though group work was good for my students it might not be best to use it all the time because it increased the likelihood that students would lose focus. After giving the survey out I tried to implement more silent work in which students maintained focus. I required that more classwork be handed in as a grade. This made it so students would have to stay focused to get their work done. I also made sure that when I felt the class was getting out of control that I was quicker to bring the class together reminding them that they were wasting time and losing focus on the subject matter.

The surveys opened up my eyes to how students interacted with one another in my classroom. There were three questions from the survey that dealt with student to student interaction and all

of them scored low. The first question was “Students push each other to do better work in this class.” and received a score of 2.575. The second question was “In this class, students review each other’s work and provide each other with helpful advice on how to improve”, which received a score of 2.675. The last question was “In this class, other students take the time to listen to my ideas.” and it received an average of 2.675 as well. I realized I needed to change the culture of my classroom to make sure all students felt that their opinions were valid and that they could go to their classmates for help with their work. The first change I made was that when a student was sharing an answer I made sure that all other students were respectful in listening to that student. I also made sure that if a student got a question wrong, that they knew it was okay and that no one else in the class should laugh or make fun of the incorrect answer. I also made sure to change how I seated certain students in the room. In my last seating chart of my practicum I made sure to place lower students with higher students in the class. This was in hopes that the higher level students would push the lower students to better their work. I also made sure to give enough time to students so they could review their work within their groups to make collaborate on questions they had and give advice to one another.

Overall, the surveys were extremely helpful in helping me reflect on my practice in the classroom. The surveys gave me insight to what my students thought of my teaching and from there I was able to adjust to fulfill the needs of my students. A graphic of the survey results can be seen in Appendix M.

Chapter 11: Measure of Student Learning

When students walked in to Ms. McDermott's classroom in September one of the first things they did besides getting acclimated to the classroom was they took a pre assessment test. This test consisted of 96 multiple choice questions, 50 of which were based off of genetics. After I finished teaching the genetics unit (which took all of my teaching practicum), I gave my students a post assessment. This assessment consisted of the same 50 genetics questions from the pre assessment. The post test can be seen in Appendix N. I was able to use the post assessment as a tool to analyze student growth. I compared pre and post assessment results for each student and each class. A majority of my students improved their test scores when comparing the two assessment. Results for each class can be seen below:

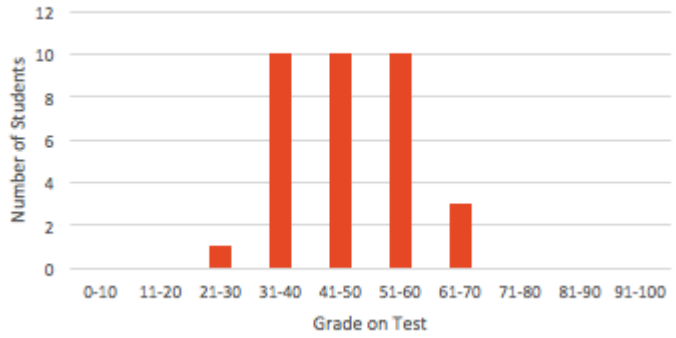

Figure 9: Red Class Pre Test Results

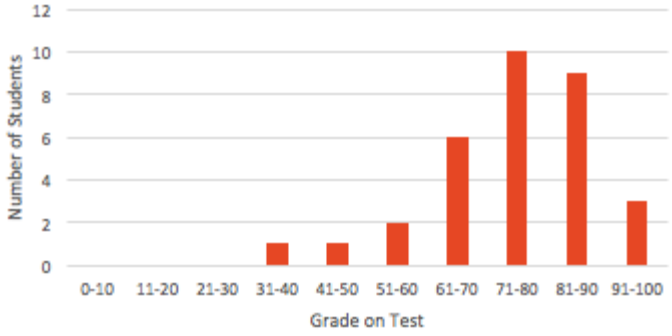

Figure 10: Red Class Post Test Results

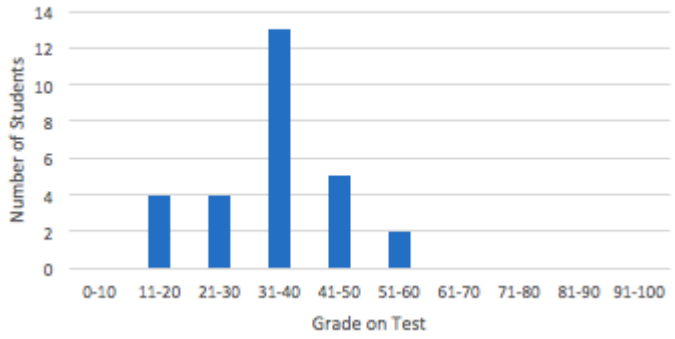

Figure 11: Blue Class Pre Test Results

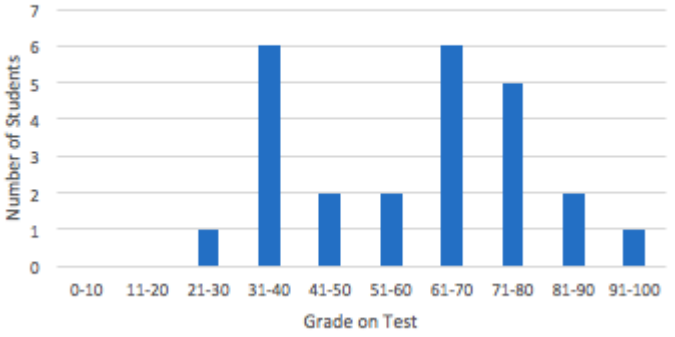

Figure 12: Blue Class Post Test Results

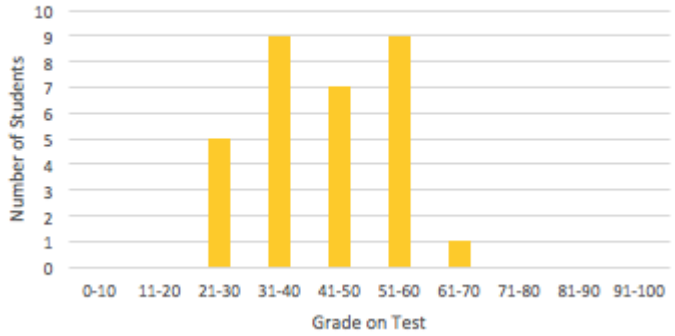

Figure 13: Yellow Class Pre Test Results

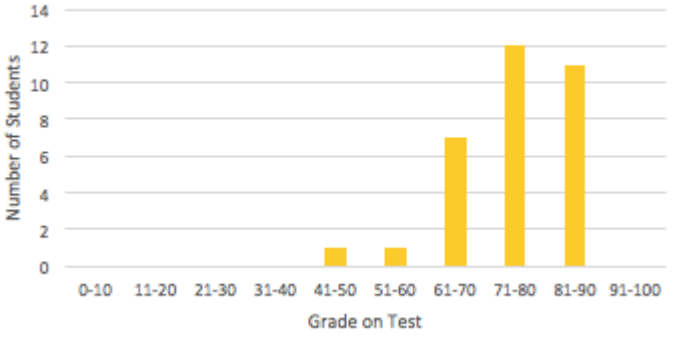

Figure 14: Yellow Class Post Test Results

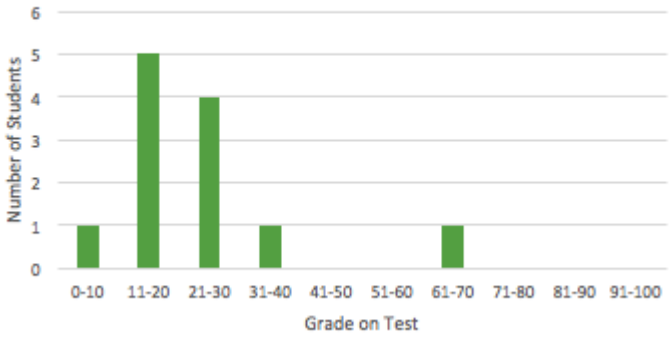

Figure 15: Green Class Pre Test Results

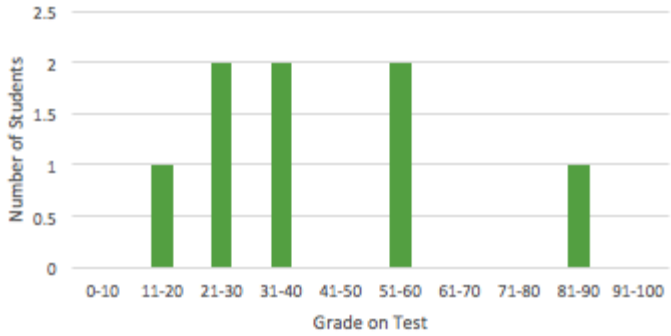

Figure 16: Green Class Post Test Results

As seen through the graphs above, the distribution of test grades shifted to the right for all classes. This indicated that test results increased from pretest to posttest. The red and yellow classes post assessment results greatly resemble a bell curve, which is expected from any assessment and shows a normal distribution of results. The class to produce the worst results from the assessment was the green class. Part of this was the fact that only nine students put in an effort to finish the post test. Though this was upsetting, when looking at the overall results of the test, students still improved their test scores. As a whole, the post assessment showed the work I did in the classroom was effective in teaching the different topics of genetics.

Chapter 12: Community Engagement

Teaching is not just contained to the classroom. It is important to show students that a teacher is not just a man or woman who lives in the school, rather teachers are normal people that have a passion to affect young individuals minds through education. In order to create a better connection with students it was important for me to create a presence in the community. To do this, I attended a STEM night at the YMCA. At this event I showed different students how to make "elephant toothpaste". This was a fun activity and students were able to see me in an environment besides the classroom. Another form of community engagement I participated in was I attended a FGMS basketball game. By attending this game I was able to show my support for my students in activities besides classwork. Students were very happy to see me at their game and as a collegiate basketball player I was able to connect with my students on another level.

Another form of community engagement I took part in was getting to know the parents of my students. During my practicum I attended several IEP and 504 meetings for specific students in my classes. Particularly, I attended an IEP for one of the students in my red class. This student was very smart and understood material to perfection, however, any work assigned outside of class he never did. During his IEP meeting, I, along with my supervising teacher and the other teachers in my cluster, confronted the student and his parents about why he wasn't doing his homework. As a group we eventually came to the conclusion that the student viewed school and home as two different things. It was in this meeting that the student with his parents would change their view on the separation of school and home. They ensured that homework would be completed at home. After this meeting I saw great improvement in this student's effort to complete his homework. This meeting gave me great insight on how much parents can influence their children. By having parents on the same page of a teacher it makes it that much easier to influence a student to do what they need to.

Besides reaching out to parents outside of the classroom, I also took on the responsibility of extending my profession outside of the classroom by attending a principals meeting. At this meeting every faculty member of the school came together to discuss certain events that would be happening in the school throughout the next month. Key events included the distribution of chrome books to every teacher in the school, a schedule for practice MCAS testing throughout the school, and lastly an overview of how the actual MCAS testing would occur in the school. The principals meeting was a great way to get every faculty member of FGMS on the same page for these events. This meeting gave me an insight into the many aspects of teaching besides the work with teachers. It helped me to recognize the many responsibilities of teaching including the administration of state or school wide tests.

Chapter 13: Conclusion

As my teaching practicum comes to an end I reminisce on how great of an experience it has been. I believed that this experience has given me great insight into the world of teaching and just how hard of a profession it is. I have gained so much more respect for both my past and current educators. Personally, successfully completing the student teaching practicum has help me overcome fears I previously had in presenting. After presenting four lessons a day for over three months I have grown very comfortable talking in front of a group of people. Prior to my teaching practicum, I always knew that teachers had a great impact on a student's life. A teacher is responsible for the success a student has in the classroom. A teacher can either positively influence a student guiding them to see the value of education or a teacher an turn a student off of a subject negatively influencing how they perceive education. It wasn't until I became a teacher with the personal responsibility of influencing young minds that I saw the full impact a teacher could have on the youth. Throughout the last 16 weeks I was able to impact the minds of 120 youths, though at times it was challenging, at the end of the day I would never take back a single moment I had with my students. I will forever be grateful for the experience I had as a teacher candidate.

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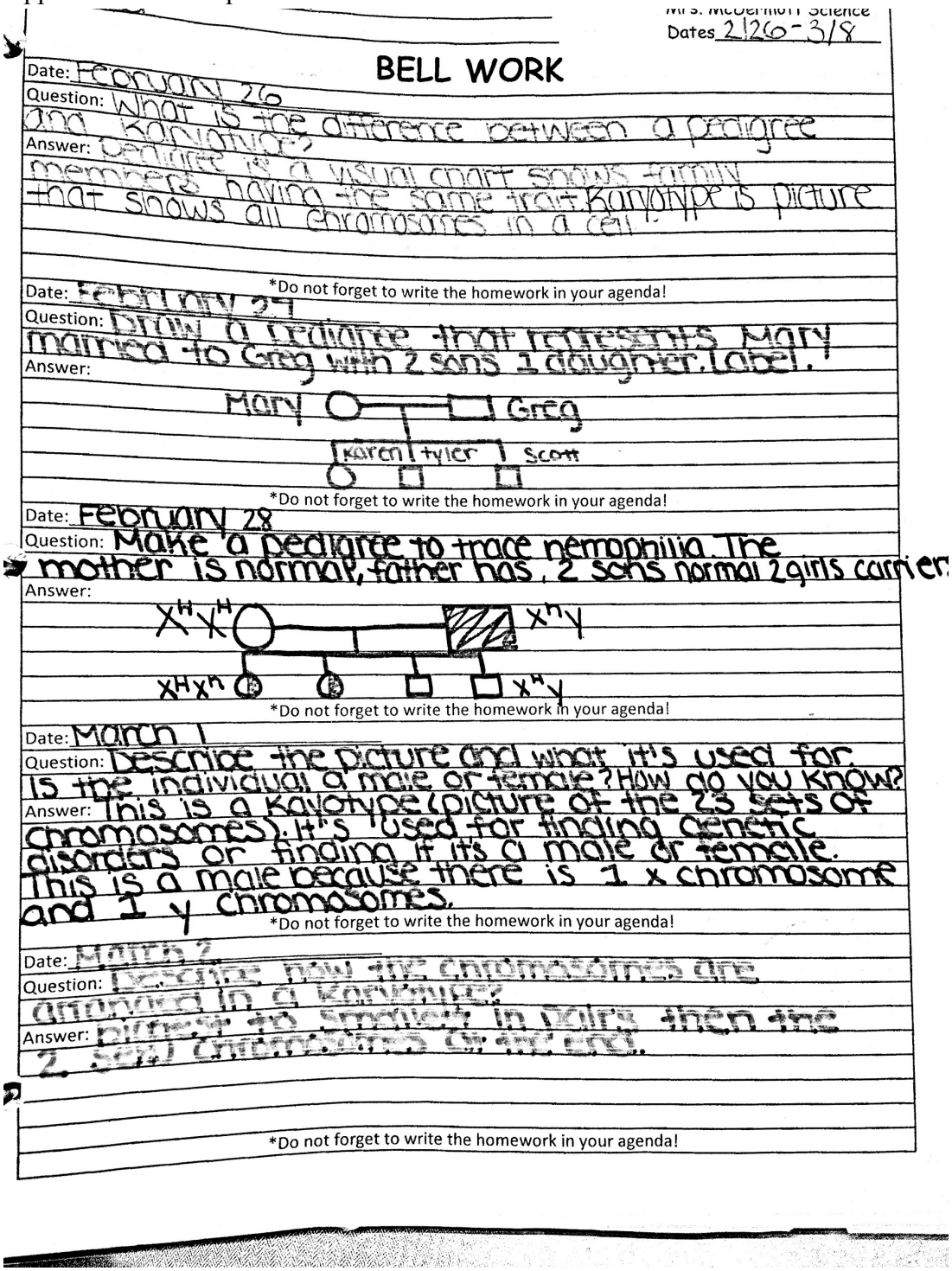
Appendices

Appendix A: Example of Students Bell Work



Mrs. McDermott Science
Dates 2/26-3/8

BELL WORK

Date: February 26
Question: What is the difference between a pedigree and karyotype?
Answer: pedigree is a visual chart shows family members having the same trait. Karyotype is picture that shows all chromosomes in a cell.

*Do not forget to write the homework in your agenda!

Date: February 27
Question: Draw a pedigree that represents Mary married to Greg with 2 sons 1 daughter. Label.
Answer:

*Do not forget to write the homework in your agenda!

Date: February 28
Question: Make a pedigree to trace hemophilia. The mother is normal, father has, 2 sons normal 2 girls carrier
Answer:

*Do not forget to write the homework in your agenda!

Date: March 1
Question: Describe the picture and what it's used for. Is the individual a male or female? How do you know?
Answer: This is a Kayotype (picture of the 23 sets of chromosomes). It's used for finding genetic disorders or finding if it's a male or female. This is a male because there is 1 x chromosome and 1 y chromosomes.

*Do not forget to write the homework in your agenda!

Date: March 2
Question: Describe how the chromosomes are arranged in a karyotype.
Answer: pictures in smallest to largest, then the 2 sex chromosomes (X and Y).

*Do not forget to write the homework in your agenda!

Appendix B: Examples of Student Work/Classwork

i. DNA Intro Reading with Questions and Drawing

DNA- Deoxyribonucleic Acid

The nucleus of the cell is analogous to the control center of the cell because it houses DNA, which is responsible for many of the cell's functions. The nucleus is a small, spherical, membrane-bound organelle found in all eukaryotic cells. It contains chromosomes, which are structures comprised of a mixture of proteins and genes. A gene is a segment of D.N.A. that codes for a specific trait.

D.N.A. (deoxyribonucleic acid) is the chemical that controls your cells because it is responsible for the production of proteins. Your entire body is made out of proteins. What the proteins are like depends on the sequence of D.N.A. So in other words, your hair, your skin, your nails, even your muscles and blood type all depend on your D.N.A. sequence, which is found in the nucleus of your cells (it is also found in the mitochondria, but it is only the D.N.A in the nucleus that controls the cell).

D.N.A is a nucleic acid composed of smaller units called nucleotides. A nucleotide is a monomer consisting of one sugar attached to a phosphate group and a nitrogen base. In D.N.A, the sugar found in the nucleotides is called deoxyribose. Deoxyribose is a sugar containing 5 carbon atoms.

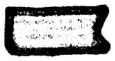
DNA is a double helix- there are two strands of DNA (double) that are twisted in a circular pattern (helix). Rosalind Franklin is known for "Photo 51", an x-ray diffraction that reveals DNA's shape. James Watson and Francis Crick were able to use Franklin's findings to confirm the shape of DNA as a double stranded twisted helix.

Imagine a twisted ladder- the sides of the ladder are made up of linked sugar and phosphate molecules, which is known as the "sugar-phosphate backbone" of D.N.A. **Color all the deoxyribose molecules purple (dark purple, medium purple will do)** **Color all the phosphates pink**

The rungs (steps) of the ladder are the nitrogen bases. The nitrogen bases follow specific "base-pairing rules", which means that adenine will only pair with thymine, and vice versa, and that guanine will only pair with cytosine, and vice versa. The nitrogen bases bond using hydrogen bonds, which are the weakest type of chemical bond; it is necessary that the bonds break apart during DNA replication. During replication DNA unzips itself, breaking the hydrogen bonds in the process. DNA replication occurs right before cell division so that new cells have a copy of DNA, too. Adenine and thymine share two hydrogen bonds, whereas cytosine and guanine share three hydrogen bonds.
In addition, guanine and adenine are bigger than thymine and cytosine. They are classified as purines (double ring structure); thymine and cytosine are classified as pyrimidines (single ring structure).

color guanine green

color cytosine yellow

color adenine orange  color thymine blue

RNA- Ribonucleic Acid

RNA is like DNA's cousin. It is very similar, but its function and composition differ in some ways. However, without RNA, DNA would not be able to do its job. RNA is short for ribonucleic acid. RNA contains a slightly different sugar called ribose. Why is RNA important? We know that DNA controls many of the cell's activities, but how? The DNA contains a sequence that is specific to one protein. There are many different DNA sequences, which code for many different proteins. For example, keratin is a protein found in your skin, hair and nails. There are many features that your skin, hair, and nails could have such as color and thickness. This all depends on your DNA sequence. In this regard, DNA is just like a code.

Like most codes, DNA's code is kept secret in the nucleus and it has to be cracked... DNA is too big to leave the nucleus. The only way out would be through the tiny holes called nuclear pores, and it simply cannot fit. That's where messenger RNA (mRNA) comes in; mRNA is smaller than DNA because it is composed of a single strand of nucleotides, whereas DNA is double stranded. So, RNA is essentially half the size of DNA. mRNA is created in the nucleus. Using a specialized enzyme, it reads the DNA's special code, and as it does so it builds itself by adding complementary nucleotides. However, there is one difference among the nucleotides of DNA and RNA. RNA does NOT contain thymine; instead, it uses a different nitrogen base called uracil. Uracil takes the place of thymine by bonding with adenine.

Once the mRNA is complete, it can leave the nucleus and deliver the DNA's "code" to the ribosomes, which are located in the cytoplasm of the cell (outside the nucleus). This is where the magic happens! In other words, the ribosomes are where all those important proteins are made.

There are different types of RNA: mRNA, tRNA and rRNA. They have different roles but contribute to making proteins.

Color the RNA strand just as you did for DNA... EXCEPT...

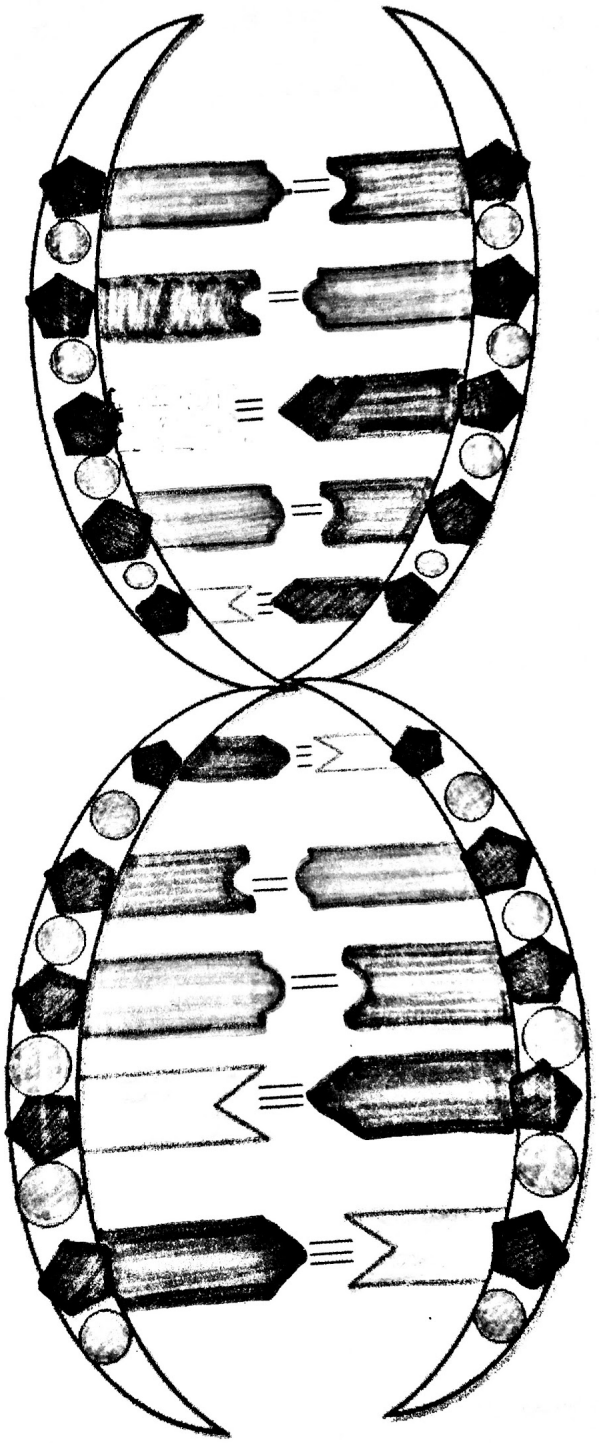
Color the ribose LIGHT PURPLE.  Color the uracil BROWN 

Analysis

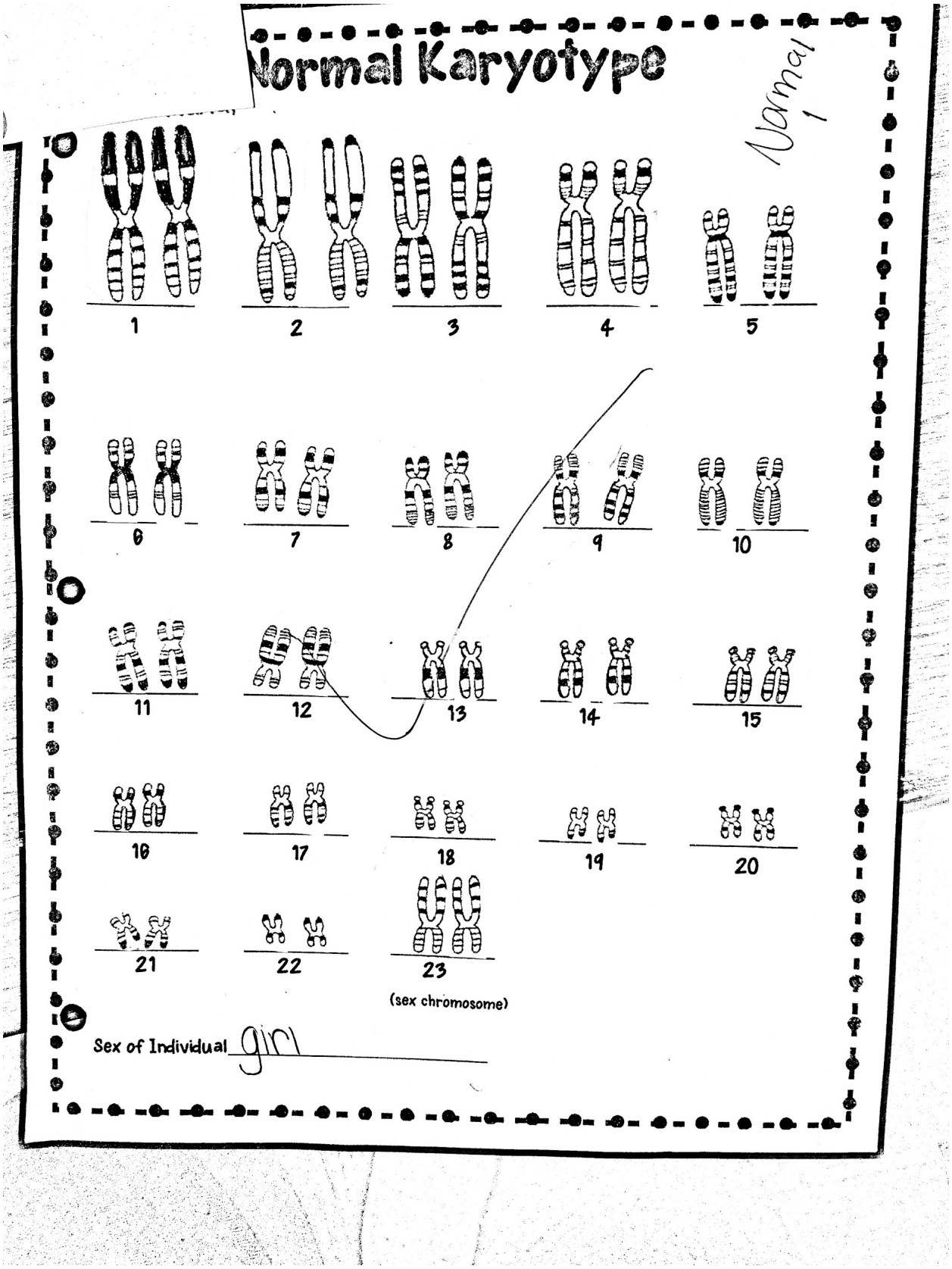
1. What is a chromosome? structures comprised of protiens
2. What is a gene? A segment of DNA that codes for a certain trait.
3. What does D.N.A. stand for? deoxyribonucleic acid
4. Where is DNA located? DNA is located in the nucleus and genes

5. Why is DNA important? because it makes proteins
6. Describe what a nucleotide is:
Monomers consisting of one sugar attached to a phosphate group and a nitrogen base.
7. Describe the shape of DNA:
It's a double-helix that looks like a twisted ladder
8. Which scientists helped to determine the shape of DNA?
Francis Crick and James Watson
9. What chemicals are the sides of the DNA ladder made of?
Sugars and phosphate molecules
10. What are the "rungs" of the DNA ladder made of?
Nitrogean bases
11. What sugar is found in DNA? deoxyribose
12. In DNA, adenine bonds with Thymine using 2 (#) hydrogen bonds; guanine bonds with Cytosine using 3 (#) hydrogen bonds.
13. What are the two purines? What are the two pyrimidines?
Adenine and Guanine Thymine and Cytosine
14. What does RNA stand for? ribonucleic acid
15. What sugar is found in RNA? ribose
16. Explain why mRNA is needed to act as a messenger- why can't the DNA just deliver itself? because DNA is too big to leave the nucleus.
17. Where are proteins made? ribosomes
18. Which nitrogen base is found in RNA that is NOT found in DNA?
Uracil What does it bond to? Adenine
19. Put the following in order from SMALLEST to LARGEST: cell, nucleus, gene, chromosome, DNA, organism, nucleotide
nucleotide, gene, DNA, chromosomes, cell, organism
20. Why is RNA smaller than DNA?
RNA is smaller than DNA because it is composed of a single strand of nucleotides instead of two.

DNA



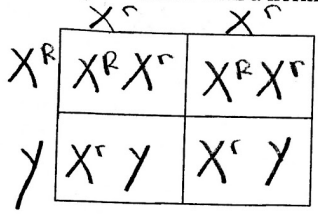
ii. Karyotype Activity



iii. Sex-Linked Traits Practice Problems Worksheet

Sex-linked Traits Practice Problems

1. In fruit flies, the gene for white eyes is sex-linked recessive. (R) is red and (r) is white. Cross a white-eyed female with a normal red-eyed male.



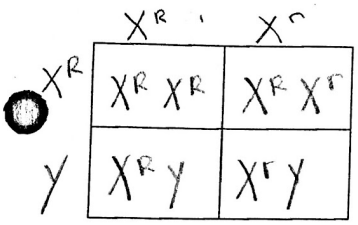
a. What percent of the males will have red eyes? White eyes?
0% for red eyes 100% white eyes

b. What percent of the females will have red eyes? White eyes?
100% for red eyes 0% for white eyes

c. What **total percent** of the offspring will be white-eyed?
50% of the offspring will be white-eyed

d. What **percent** of the offspring will be carriers of the white eye trait?
50% of the offspring will be carriers of the white eyed trait

2. Using the same information as for question #1, cross a heterozygous red-eyed female with a red-eyed male.



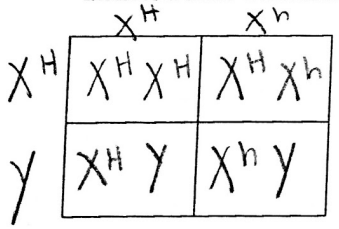
a. What are the genotypes of each parent?
$X^R X^r$ $X^R Y$

b. What **fraction** of the children will have red eyes?
3/4

c. What **fraction** of the children will have white eyes?
1/4

d. What **fraction** of the female children will carry the white eyed trait?
1/2

3. In humans, hemophilia is a sex-linked recessive trait. If a female who is a carrier for hemophilia marries a male with normal blood clotting, answer the following questions.



a. What fraction of the female children will have hemophilia?
0/2

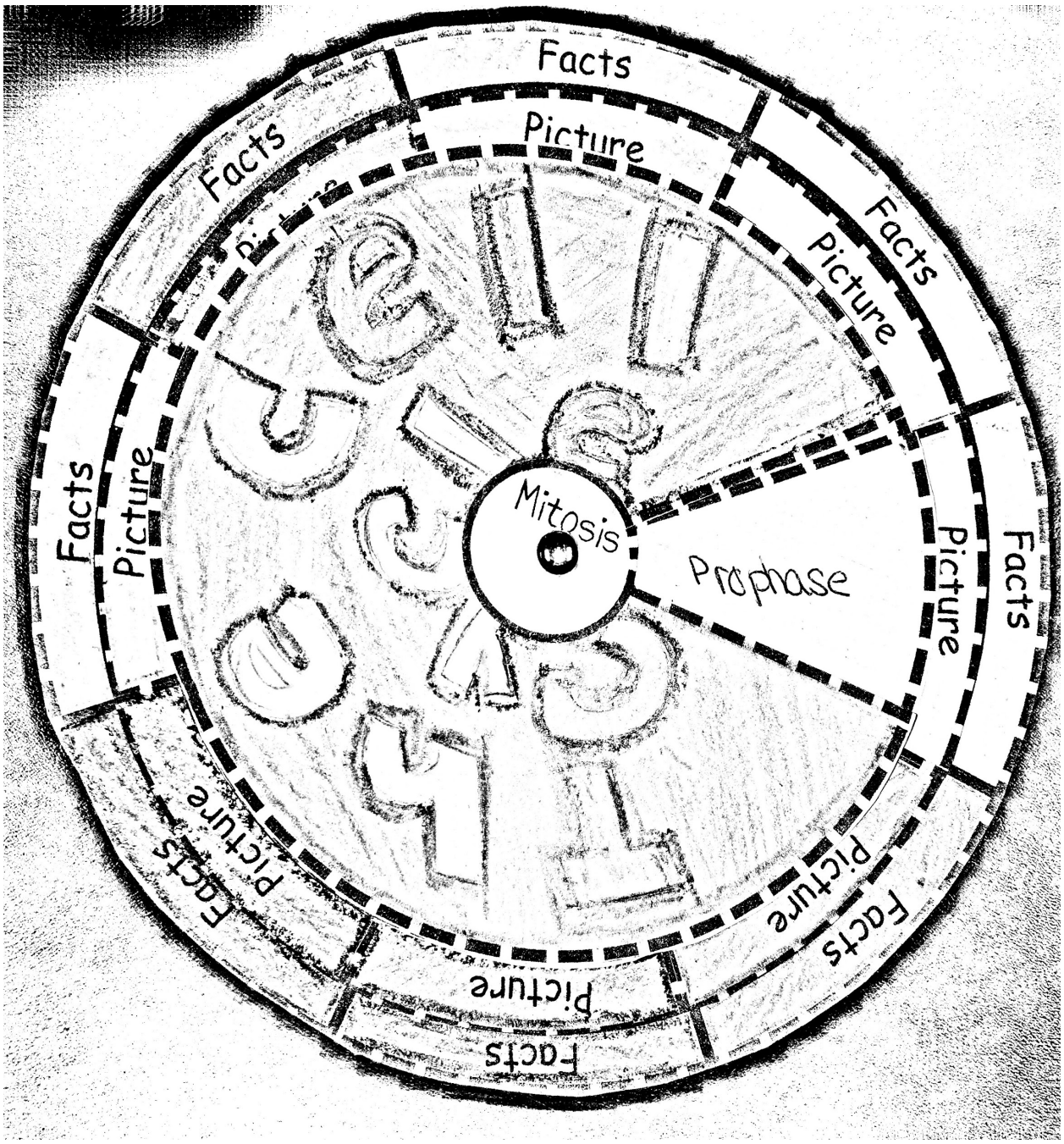
b. What fraction of the female children will be carriers?
1/2

c. What fraction of the male children will have normal blood clotting?
1/2

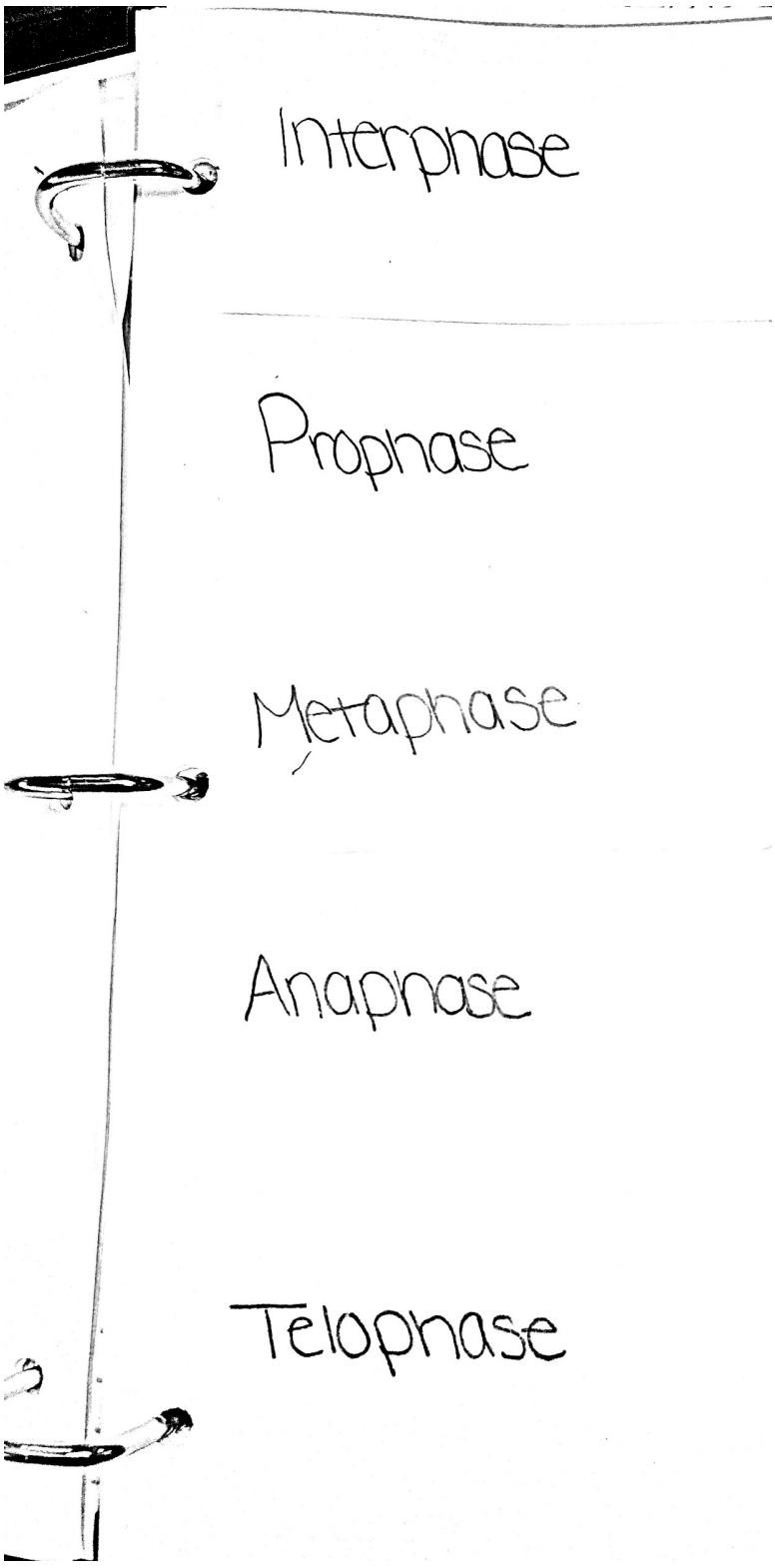
d. What fraction of the male children will be carriers? 0/2

e. What fraction of the male children will have hemophilia? 1/2

iv. Cell Cycle Wheel



v. Mitosis Interactive Notes


Interphase
Prophase
Metaphase
Anaphase
Telophase

Cell is doing its job

DNA is copied
You can see the
chromosomes

Chromosomes line up
in the middle.

Chromosomes
move apart.

Two new cells are
formed

Nucleus goes back
to normal.

Genetics: X Linked Genes

******In fruit flies, eye color is a sex linked trait. Red eye color is dominant to white ******

1. What are the sexes and eye colors of flies with the following genotypes?

X^RX^r F - Red X^RY M - Red X^rX^r F - White

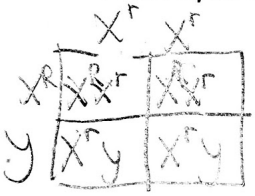
X^RX^R F - Red X^rY M - White

2. What are the genotypes of these flies:

white eyed, male X^rY red eyed female (heterozygous) X^RX^r

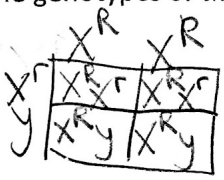
white eyed, female X^rX^r red eyed, male X^RY

3. Show the cross of a white eyed female X^rX^r with a red-eyed male X^RY.



4. Show a cross between a pure red eyed female and a white eyed male.

What are the genotypes of the parents: X^RX^R & X^rY



What percentage is:

white eyed, male 0

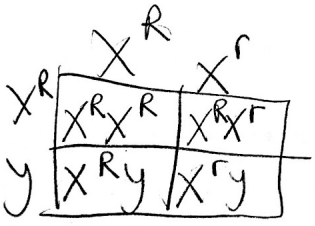
white eyed, female 0

red eyed, male 100%

red eyed, female 100%

5. Show the cross of a red eyed female (heterozygous) and a red eyed male.

What are the genotypes of the parents: X^RX^r & X^RY



What percentage is:

white eyed, male 50%

white eyed, female 0

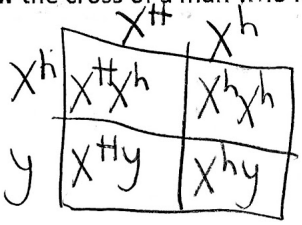
red eyed, male 50%

red eyed, female 100%

6. In humans, hemophilia is a sex linked trait. Females can be normal, carriers, or have the disease. Males will either have the disease or not (but they will never be carriers)
What are the sexes and conditions of people with the following genotypes?

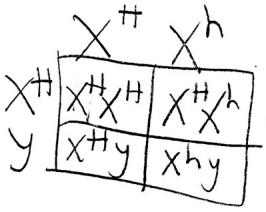
X^HX^h F- carrier
X^HX^H F- No
X^HY M- No
X^hY M- Yes
X^hX^h F-, Yes

7. Show the cross of a man who has hemophilia with a woman who is a carrier.



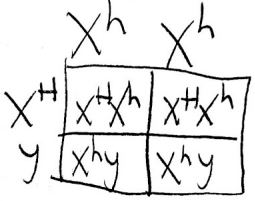
What is the probability that their sons will have the disease? 50%
What is the probability that their daughters will have the disease? 50%

8. A woman who is a carrier marries a normal man. Show the cross.



What sex will a child in the family with hemophilia be? male

9. A woman who has hemophilia marries a normal man. Show the punnett square.



What percentage of their children will have hemophilia, and what is their sex?
50% - male

Appendix C: Lesson Plans

i. My Traits, Your Traits

January 23: My Traits, Your Traits

Teacher's Name: Katie Nugent **Subject/Course: Science**

Unit: Genetics **Grade Level: 8th**

Overview of and Motivation for Lesson:

Click here to enter text.

Stage 1-Desired Results

Standard(s):

- Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

Aim/Essential Question:

- What are some common inherited traits in human?

Understanding(s):

Students will understand that . . .

- certain traits are inherited while others are controlled by the environment
- there are dominant and recessive traits in a population

Content Objectives:

Students will be able to . . .

- identify their own traits
- calculate a percentage
-

Language Objectives:

ELD Level Choose an item. *Students will be able to . . . in English*

Click here to enter text.

ELD Level Choose an item. *Students will be able to . . . in English*

- Click here to enter text.

Key Vocabulary

- inherited traits
- acquired trait
- variation
- gene
- dominant
- recessive

Stage 2-Assessment Evidence

Performance Task or Key Evidence

- My Traits, Your Traits lab activity

Key Criteria to measure Performance Task or Key Evidence

- Teacher going around the class to ensure students understand

Stage 3- Learning Plan

Learning Activities:

Do Now/Bell Ringer/Opener: List four human traits that you think all human possess.

Learning Activity 1:
Bill Nye Video

Learning Activity 2:
My Traits, Your Lab activity. Students look at their own traits and compare it to the class

Application
Students can look at their own traits and determine if they are dominant or recessive.

Summary/Closing
Only half of the activity will be done in class, the rest will be completed the next day in class

Multiple Intelligences Addressed:

☒ Linguistic	☒ Logical-Mathematical	☐ Musical	☒Bodily-kinesthetic
☐ Spatial	☒ Interpersonal	☐Intrapersonal	☐Naturalistic

Student Grouping

☒ Whole Class	☒ Small Group	☐ Pairs	☒ Individual

Instructional Delivery Methods

☒ Teacher Modeling/Demonstration	☐ Lecture	☒ Discussion
☒ Cooperative Learning	☐ Centers	☐ Problem Solving
☐ Independent Projects		

Accommodations	**Modifications**
How to get the percentage of dominant or recessive will be demonstrated by the teacher.	Click here to enter text.

Homework/Extension Activities:
No HW

Materials and Equipment Needed:

- My Traits, Your Traits activity
- Pen/Pencil
- Calculator
- Overhead projector

Do Now → Twins Separated @ Birth → mostly similar & Bc diff environments have many differences.

My Traits, Your Traits

Determining Inherited Traits

Organisms are described by their characteristics, or **traits**, such as shape, color, and height. Some traits are **inherited**, and some are **acquired** as the result of environmental influences. It is the combination of all an organism's traits that makes it unique.

Inherited traits are controlled by genes. A **gene** is a specific section of a chromosome which contains the code to produce a trait. Offspring receive half of their genes from one parent and half of them from the other parent. Many inherited traits have at least two different forms or **variations**. One variation may mask or hide another variation of that same trait. We say that this trait is **dominant** over the other. For example, a person's eyes may be brown or blue; these are two variations of eye color. A baby that receives a gene for brown eyes from one parent and a gene for blue eyes from the other parent will have brown eyes. The gene for brown eyes is dominant over the gene for blue eyes. The variation which is hidden (blue eyes) is said to be **recessive**. In this activity, you will observe variations of some human traits and consider which traits are inherited and which are under environmental control.

Students read

Questions

1. What are some common inherited traits in humans?
2. Can you distinguish between traits which can and cannot be inherited?
3. What is the difference between dominant and recessive traits?

} Keep these in mind

Text Reference

Life Science (McDougal), pp. 101-102.

Key Terms

inherited trait
acquired trait
variation
gene
dominant
recessive

} quick go over

Before You Begin

List four human traits that you think all humans possess.

Don't Skip.

* Dominant does not mean more common → look @ Denmark

* Name, Class, Date on Paper.

Directions

The first column of the following is a list of some common human traits that are under genetic control. Read the trait variations in the other two columns and circle the form of trait that you have.

Human Trait	Dominant Variation of Trait	Recessive Variation of Trait
hands clasped together	left thumb over right	right thumb over left
wave in hair	curly	straight
hairline at forehead	"widow's peak"	straight hairline
dimples	yes	no
ear lobes	free	attached
tongue	can be rolled	can't be rolled
freckles	yes	no

Analysis

1. How many of the dominant traits listed do you have?

2. How many of the recessive traits listed do you have?

3. Follow your teacher's directions to complete this class data table.

Class Data Table: Traits and Variations (Total number of students in the class = 34)

Human Trait	Number of Students with Dominant Variation of Trait	% of Students with Dominant Variation of Trait	Number of Students with Recessive Variation of Trait	% of Students with Recessive Variation of Trait
hands clasped together	20		14	
wave in hair				
hairline at forehead				
dimples				
ear lobes				
tongue				
freckles				

4. Which variations of the traits are most common in your class?

5. Are the dominant traits in a population always the most common?

Traits which are controlled by genes alone are called **inherited traits**. Other traits are totally influenced by the environment and are called **acquired traits**. Some human traits are not simply controlled by the person's genes, but instead they are the result of interactions of genes with the environment. For example, a person with naturally straight hair may have a permanent to create curly hair. A person who inherits genes for tallness may not grow to be tall because of disease or poor diet.

6. Think about each of the human traits in the following chart and check (✓) the column which best describes the way that trait is controlled.

Human Trait	Genetic Control	Environmental Control	Both
muscle size			
height			
eye color			
favorite type of music			
artistic talent			
body weight			
freckles			
favorite food			
athletic ability			

7. Choose any one of the traits which you think is controlled by both genetics and the person's environment and explain how both factors can affect the trait.

Conclusion

1. One characteristic (trait) of humans is that they have five fingers on each hand.
   (a) List three other characteristics common to humans.

   (b) For each of the answers you stated above, think of a variation which is inherited. For example, humans have five fingers on each hand -- some people have very long fingers and some people have short fingers.

2. Explain how you came to have the unique traits that you possess. Are all your traits the result of heredity? Explain.

Application

1. Refer to your original list of traits in **Before You Begin** on the first page of this lab activity. Based on what you have learned about heredity and environmental influences on traits, label each of the traits on your list with an **H** for heredity, an **E** for environmental, or a **B** for Both.

2. Lucia grew up in Argentina and speaks fluent Spanish. Is this an example of an inherited trait or is the trait influenced by the environment? Explain the reasoning behind your answer.

ii. Plastic Egg Lab

Plastic Egg Genetics: February 5th

Teacher's Name: Katie Nugent **Subject/Course: Science**
Unit: Genetics **Grade Level: 8th**

Overview of and Motivation for Lesson:
Click here to enter text.

Stage 1-Desired Results

Standard(s):
- Recognize that heredity information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

Aim/Essential Question:
- Why are there genetic differences between parent and offspring

Understanding(s):
Students will understand that . . .
- dominant traits over mask recessive traits
- although you may not see a trait does not mean its not there
- parents can have different phenotypes from their offspring

Content Objectives:
Students will be able to . . .
- conduct an experiment to discover different phenotypic and genotypic combinations
- conduct a Punnett square to predict the genotype and phenotype when two parents have an offspring

Language Objectives:
ELD Level Choose an item. *Students will be able to . . . in English*
Click here to enter text.
ELD Level Choose an item. *Students will be able to . . . in English*
- Click here to enter text.

Key Vocabulary
- Punnett square
- Homozygous
- Heterozygous
- Dominant
- Recessive
- Allele

Stage 2-Assessment Evidence

Performance Task or Key Evidence
- Plastic egg lab

Key Criteria to measure Performance Task or Key Evidence
- Click here to enter text.

Stage 3- Learning Plan

Learning Activities:

Do Now/Bell Ringer/Opener: What does hybrid mean? What does purebred mean?

Learning Activity 1:
Plastic Egg Genetics Lab

Learning Activity 2:
Click here to enter text.

Application
This activity can be used as a visual to punnett squares. An egg can have a certain inside (represents a recessive trait) while physically demonstrating a different trait (the dominant trait).

Summary/Closing

Multiple Intelligences Addressed:

☒ Linguistic	☐ Logical-Mathematical	☐ Musical	☒Bodily-kinesthetic
☐ Spatial	☒ Interpersonal	☐Intrapersonal	☐Naturalistic

Student Grouping

☐ Whole Class	☐ Small Group	☒ Pairs	☒ Individual

Instructional Delivery Methods

☒ Teacher Modeling/Demonstration	☐ Lecture	☒ Discussion
☐ Cooperative Learning	☐ Centers	☐ Problem Solving
☐ Independent Projects		

Accommodations	**Modifications**
Click here to enter text.	Click here to enter text.

Homework/Extension Activities:
Finish lab questions
research project

Materials and Equipment Needed:

- basket Of 12 different coloring eggs
- skittles
- genotype and phenotype chart

Plastic Egg Genetics – Student Sheet

Introduction

On the lab table, there a variety of plastic eggs. Each egg represents the fertilized eggs from two parents. Each half of the colored egg represents the phenotype of one of the parents. For example, if the egg is half purple and half pink, the phenotype of one of the parent is purple and the other is pink.

Materials

- ☐ Basket of 12 different colored eggs
- ☐ Jelly beans
- ☐ Genotype and phenotype chart

Procedure

1. Use the following genotype and phenotype chart.

Chart
PP = purple
pp = pink
Pp = orange
BB = blue
bb = yellow
Bb = green

2. Each student in a group should pick 3 different eggs. One by one complete the phenotype and genotype for each egg.

3. After you have completed your 3 charts share your thinking and results with the whole group.

4. When all 12 eggs have been discussed, verify your answers with the teacher.

5. Complete the Punnett Squares for your egg and write your phenotype and genotype results.

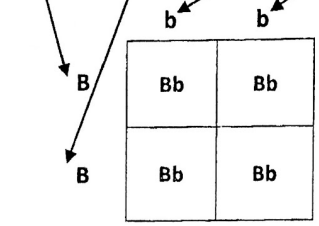
6. Place the proper jelly beans that correspond with the offspring inside of the egg.

7. Complete the Group Results chart.

For Example Egg

Phenotype: My egg is ½ **Blue** and half **Yellow**.

Genotype: (**B** **B**) x (**b** **b**)



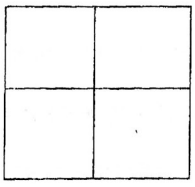
Punnett Square

My Results: 4 (Bb) all green **Inside the Egg:** 4 green pieces

First Egg

Phenotype: My egg is ½ _____ and half _____.

Genotype: (_____ _____) x (_____ _____)



Punnett Square

My Results: _____ **Inside the Egg:** _____

Group Results

Egg	½ Color	Genotype	½ Color	Genotype	Results		
					#XX	#Xx	#xx
Example	Blue	BB	Yellow	Bb	2 BB - blue	2 Bb - green	0
1	Purple		Purple				
2	Purple		Pink				
3	Pink		Pink				
4	Orange		Orange				
5	Orange		Purple				
6	Orange		Pink				
7	Blue		Blue				
8	Blue		Yellow				
9	Blue		Green				
10	Yellow		Yellow				
11	Green		Yellow				
12	Green		Green				

Questions:

1. **Why are there genetic difference between parents and offspring?**

2. **Explain how a pink flower can be an offspring of parent plants with red flowers.**

iii. Meiosis Animation and Kahoot Lesson

Meiosis Animation Biomanbio: Click here to enter text.

Teacher's Name: Katie Nugent **Subject/Course: Science**
Unit: Genetics **Grade Level: 8th**

Overview of and Motivation for Lesson:
Click here to enter text.

Stage 1-Desired Results

Standard(s):
- Compare Sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell)
-

Aim/Essential Question:
- What are the different phases of Meiosis?

Understanding(s):
Students will understand that . . .
- Meiosis creates sex cells that have half the genetic information as a normal cell
- Sex cells are necessary for sexual reproduction
- There is a multi step process in order to create sex cells
-

Content Objectives:	**Language Objectives:**
Students will be able to . . . • Use a video animation to visualize the different events that take place in meiosis • Describe the events that take place in meiosis	ELD Level *Students will be able to . . . in English* ELD Level *Students will be able to . . . in English* •

Key Vocabulary
- chromosomes
- gene
- meiosis
- prophase
- metaphase
- anaphase
- telophase
- interphase
- cytokinesis
- gametes
-

Stage 2-Assessment Evidence

Performance Task or Key Evidence

Key Criteria to measure Performance Task or Key Evidence

Stage 3- Learning Plan

Learning Activities:

Do Now/Bell Ringer/Opener: Describe the product of meiosis.

Learning Activity 1:

Have students work in pairs. Each pair should have one chromebook each.

https://biomanbio.com/HTML5GamesandLabs/Genegames/snurflemeiosishtml5page.html

Students should go through the video animation while answering the questions to the worksheet.

Students will have 30 minutes to get this accomplished

Learning Activity 2:

We will do a kahoot as a class. I will demonstrate how to set up the kahoot on each chromebook. Each pairing will be their own team. We will do the kahoot activity as a class. Interactive and competitive way to see if students understand meiosis and the difference between mitosis and meiosis.

Application

Meiosis makes our sex cells so we can reproduce.

Summary/Closing

If time have student make a bell work paper explaining the difference between mitosis and meiosis.

Multiple Intelligences Addressed:

☐ Linguistic	☐ Logical-Mathematical	☒ Musical	☒Bodily-kinesthetic
☐ Spatial	☒ Interpersonal	☐Intrapersonal	☐Naturalistic

Student Grouping

☒ Whole Class	☐ Small Group	☒ Pairs	☐ Individual

Instructional Delivery Methods

☐ Teacher Modeling/Demonstration	☐ Lecture	☐ Discussion
☒ Cooperative Learning	☐ Centers	☐ Problem Solving
☐ Independent Projects		

Accommodations	**Modifications**
Click here to enter text.	Click here to enter text.

Homework/Extension Activities:

No HW

Materials and Equipment Needed:

Snurfle Meiosis

Name: _____ **Date:** _____

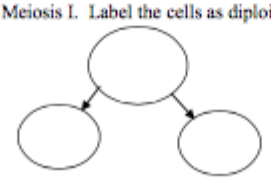
- **Click on Snurfle Meiosis App**
- **Click on Continue**
- **Click on Continue**
- **Click on Meiosis and Genetics Interactive and follow directions as you answer the following questions.**

1. When does interphase occur? _____
2. What occurs during interphase? _____
3. Uncoiled stringy DNA is called _____.
4. Human cells have _____ pieces of chromatin.
5. Half of you DNA comes from your _____ and half from your _____.
6. DNA has _____ that determines traits of an organism.
7. Different forms of a gene are called _____.
8. What are the 2 alleles for fur color in Snurfles and which letters represent those alleles?

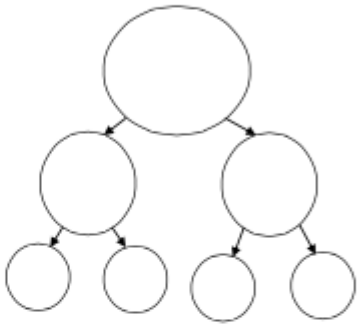
9. _____is when DNA copies itself and it occurs during _____.
10. _____ are made during Meiosis. Examples of gametes are _____ and _____.
11. Meiosis occurs in _____ divisions, Meiosis___ and Meiosis_____.
12. List the phases for Meiosis I.

13. List the phases for Meiosis II.

14. During prophase I the chromosomes _____ and become _____.
15. Chromosomes that are the same size and have the same genes are called _____.
16. Each half of a replicated chromosome is called a _____ _____.
17. Sister chromatids of a chromosome are _____.
18. The nucleus _____ during prophase I.
19. Homologous chromosomes pair up during prophase I to form a _____.
20. During metaphase I the tetrads line up in the _____ of the cell.
21. The homologous chromosomes split up and move toward the opposite ends of the cell during _____.
22. _____ independent cells begin to form during _____.
23. _____ is the division of the cytoplasm to make two new cells.
24. The 2 new cells that are formed from Meiosis I are _____ because they contain half of the chromosome of the original cell that started meiosis.
25. At the start of Meiosis I you had 1 _____ cell.
26. Meiosis II must take place because each of our new cells still has too much _____.
28. Draw the chromosomes in Meiosis I. Label the cells as diploid or haploid



29. The nucleus _____ during prophase II.
30. In Metaphase II the chromosomes line up single file down the _____ of the cell.
31. In _____ the sister chromatids split up.
32. In Telophase II, _____ _____ daughter cells are being formed. They are called _____.
33. Each newly formed cell will form a _____ around the chromosomes.
34. The chromosomes _____ to form _____.
35. _____ occurs at the same time at Telophase II.
36. At the end of Meiosis II you have made _____ _____ gametes (sex cells).
37. Draw and label the Meiosis summary.



38. If the gametes are produced by a female, they are called _____ or _____.
39. If the gametes are produced by a male, they are called _____.
40. The _____ square is a tool that is used to predict the possible offspring of a genetic cross.
41. The letters on a punnett square actually represent possible _____.
42. When sperm and egg join it is called _____.
43. A fertilized egg is called a _____.
44. Complete the punnett square to the right.
45. A _____ is the genetic make-up of an organism.
46. Give examples of genotypes.
47. A _____ is the characteristic or appearance of the organism.

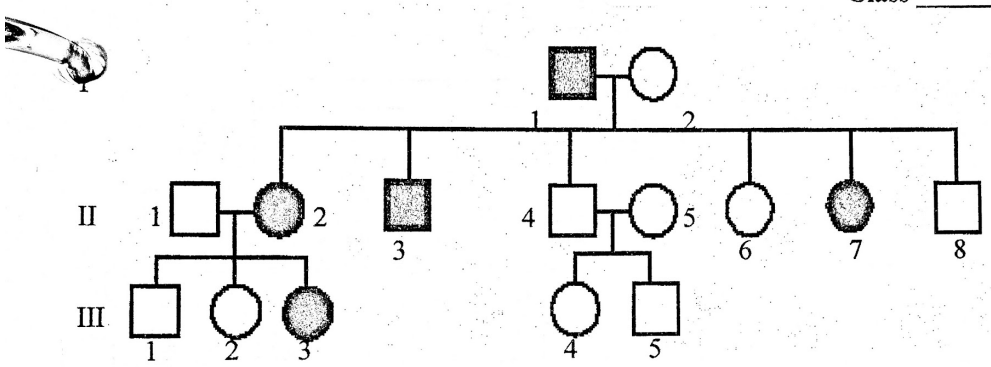
	G	g
G		
g		

48. Give examples of phenotypes.
49. Dominant alleles are represented by _____ letters.
50. Recessive alleles are represented by _____ letters.
51. _____ alleles will show in your phenotype even if it only has one copy.
52. For recessive traits to show in the phenotype the snurfle will need _____ copies of the gene.
53. _____ means an organism has 2 copies of the same allele in its genotype (GG, gg)
54. _____ means an organism has 2 different alleles in its genotype (Gg, Tt, Rr)

- **Click on The Chromosome Quandary and follow the directions**
- **Click on The Meiosis and Genetics Quiz! Answer the questions.**
- **Click on Score Sheet. Record Scores.** Overall Score: _____ Meiosis and Genetics: _____
  Chromosome Quandary: _____ Quiz: _____ Teacher's Initials: _____

Appendix D: Huntington's Disease Pedigree Question

Class _____ Date _____



1. Which members of the family above are afflicted with Huntington's Disease?

_____

2. There are no carriers for Huntington's Disease- you either have it or you don't. With this in mind, is Huntington's disease caused by a dominant or recessive trait? _____

3. How many children did individuals I-1 and I-2 have?

Appendix E: Student Assessments

i. DNA, Genes, and Chromosomes Quiz

Student A:

Match the following definitions to the correct vocabulary term.

C 1.) DNA

A 2.) Gene

B 3.) Chromosome

A.) Condensed or compact "rod" of DNA that carries genetic information.

B.) A segment of DNA that controls protein production.

C.) Deoxyribonucleic acid; helical molecule that carries the genetic information of an organism and is passed from parent to offspring.

Write the letter on the line of the choice that best answers each question.

B 4.) How many nitrogenous bases are there in DNA?

A.) 1
B.) 2
C.) 3
D.) 4

9
15

D 5.) Which of the following is not a nitrogenous base found in DNA?

A.) Adenine
B.) Cytosine
C.) Guanine
D.) Uracil

A 6.) DNA is made up of Nitrogenous base pairs. The bases bond in which of the following patterns?

A.) Adenine – Thymine; Cytosine – Guanine
B.) Adenine – Cytosine; Guanine – Thymine
C.) Adenine – Guanine; Cytosine – Thymine
D.) Adenine – Guanine; Cytosine – Taurine

D 7.) DNA looks like a "twisted ladder". If the "rungs" of the ladder are made up of nitrogenous bases, what are the hand rails or backbone of the ladder made up of?

A.) Sugars and Salts
B.) Phosphates
C.) Sugars
D.) Sugars and Phosphates

C 8.) Where is DNA located in the cell?

A.) Mitochondria
B.) Cell Membrane
C.) Nucleus
D.) Golgi Body

B 9.) How many chromosomes do we get from our mother?

A.) 46 B.) 23
C.) 22 D.) 20

C 10.) Who is credited with discovering the structure of DNA?

A.) Crick and Neck B.) Watson and Crick
C.) Watson and Franklin D.) Holmes and Watson

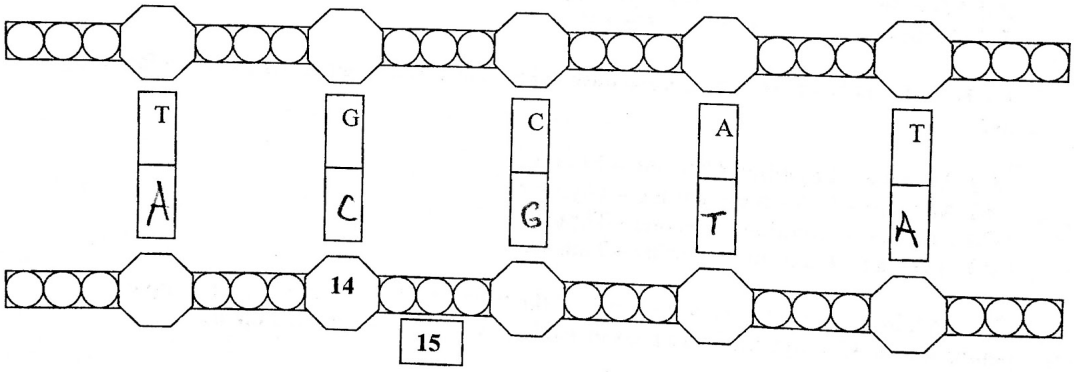
B 11.) A baby is XY for the gender or sex chromosome. The baby will be a ___?

A.) Boy B.) Girl
C.) Puppy D.) Can't tell

B 12.) The Nitrogenous bases are held together by

A.) Nitrogen Bonds B.) Hydrogen Bonds
C.) Glue D.) Calcium Bonds

13. *Label the parts of the following diagram and complete the DNA sequence by filling in the missing Nitrogenous bases.*



14. _____

15. _____

Student B:

Match the following definitions to the correct vocabulary term.

C 1.) **DNA**

BA 2.) **Gene**

B 3.) **Chromosome**

A.) Condensed or compact "rod" of DNA that carries genetic information.

B.) A segment of DNA that controls protein product

C.) Deoxyribonucleic acid; helical molecule that carries the genetic information of an organism and is passed from parent to offspring.

Write the letter on the line of the choice that best answers each question.

4 4.) **How many nitrogenous bases are there in DNA?**

12
15

A.) 1
B.) 2
C.) 3
D.) 4

D 5.) **Which of the following is not a nitrogenous base found in DNA?**

A.) Adenine **B.) Cytosine**
C.) Guanine **D.) Uracil**

A 6.) **DNA is made up of Nitrogenous base pairs. The bases bond in which of the following patterns?**

A.) Adenine – Thymine; Cytosine – Guanine
B.) Adenine – Cytosine; Guanine – Thymine
C.) Adenine – Guanine; Cytosine – Thymine
D.) Adenine – Guanine; Cytosine – Taurine

D 7.) **DNA looks like a "twisted ladder". If the "rungs" of the ladder are made up of nitrogenous bases, what are the hand rails or backbone of the ladder made up of?**

A.) Sugars and Salts **B.) Phosphates**
C.) Sugars **D.) Sugars and Phosphates**

C 8.) **Where is DNA located in the cell?**

A.) Mitochondria **B.) Cell Membrane**
C.) Nucleus **D.) Golgi Body**

B 9.) How many chromosomes do we get from our mother?

A.) 46 B.) 23
C.) 22 D.) 20

B 10.) Who is credited with discovering the structure of DNA?

A.) Crick and Neck B.) Watson and Crick
C.) Watson and Franklin D.) Holmes and Watson

A 11.) A baby is XY for the gender or sex chromosome. The baby will be a ___?

A.) Boy B.) Girl
C.) Puppy D.) Can't tell

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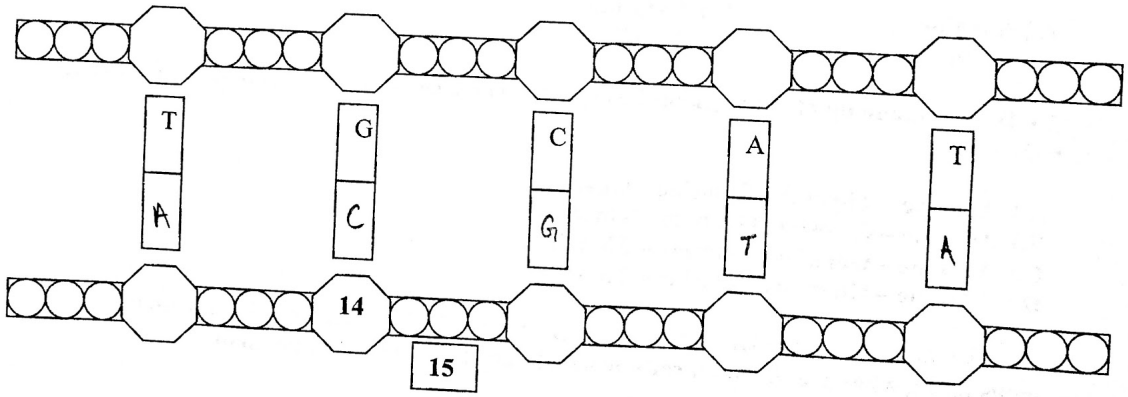
A.) Nitrogen Bonds B.) Hydrogen Bonds
C.) Glue D.) Calcium Bonds

13. *Label the parts of the following diagram and complete the DNA sequence by filling in the missing Nitrogenous bases.*



14. Sugar

15. Phosphates

Student C:

DNA, Genes, and Chromosome Quiz

Match the following definitions to the correct vocabulary term.

C 1.) DNA

B 2.) Gene

A 3.) Chromosome

A.) Condensed or compact "rod" of DNA that carries genetic information.

B.) A segment of DNA that controls protein production.

C.) Deoxyribonucleic acid; helical molecule that carries the genetic information of an organism and is passed from parent to offspring.

Write the letter on the line of the choice that best answers each question.

D 4.) How many nitrogenous bases are there in DNA?

15/15

A.) 1
B.) 2
C.) 3
D.) 4

D 5.) Which of the following is not a nitrogenous base found in DNA?

A.) Adenine
B.) Cytosine
C.) Guanine
D.) Uracil

A 6.) DNA is made up of Nitrogenous base pairs. The bases bond in which of the following patterns?

A.) Adenine – Thymine; Cytosine – Guanine
B.) Adenine – Cytosine; Guanine – Thymine
C.) Adenine – Guanine; Cytosine – Thymine
D.) Adenine – Guanine; Cytosine – Taurine

D 7.) DNA looks like a "twisted ladder". If the "rungs" of the ladder are made up of nitrogenous bases, what are the hand rails or backbone of the ladder made up of?

A.) Sugars and Salts
B.) Phosphates
C.) Sugars
D.) Sugars and Phosphates

C 8.) Where is DNA located in the cell?

A.) Mitochondria
B.) Cell Membrane
C.) Nucleus
D.) Golgi Body

B 9.) How many chromosomes do we get from our mother?

A.) 46 B.) 23
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B 10.) Who is credited with discovering the structure of DNA?

A.) Crick and Neck B.) Watson and Crick
C.) Watson and Franklin D.) Holmes and Watson

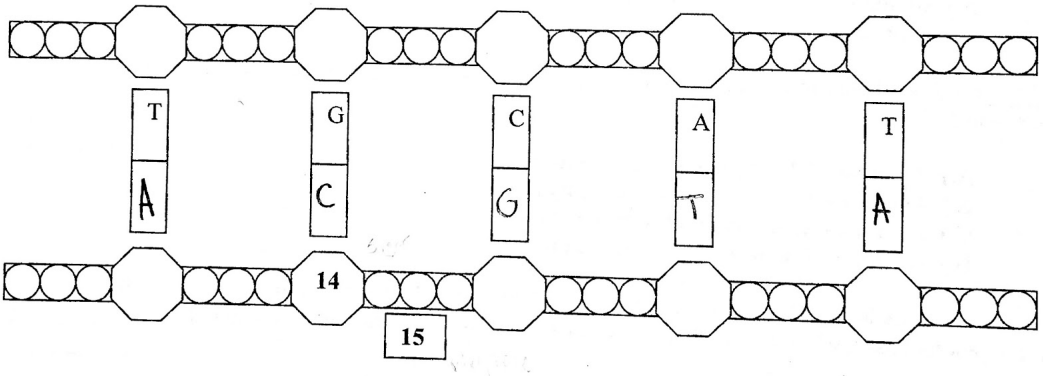
A 11.) A baby is XY for the gender or sex chromosome. The baby will be a ___?

A.) Boy B.) Girl
C.) Puppy D.) Can't tell

B 12.) The Nitrogenous bases are held together by

A.) Nitrogen Bonds B.) Hydrogen Bonds
C.) Glue D.) Calcium Bonds

13. *Label the parts of the following diagram and complete the DNA sequence by filling in the missing Nitrogenous bases.*



14. Sugar

15. phosphate

ii. Codominance/ Incomplete Dominance and Sex-Linked Traits Quiz

Student A:

Complete the following problems.

1. In some chickens, the gene for feather color is controlled by codominance. The allele for black is B and the allele for white is W. The heterozygous phenotype is known as erminette (black and white spotted).

a. What is the genotype for black chickens? BB

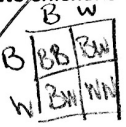
b. What is the genotype for white chickens? WW

c. What is the genotype for erminette chickens? BW

2. Using a Punnett Square show the probability if two erminette chickens were crossed.

a. They would have a black chick? 25 %

b. They would have a white chick? 25 %



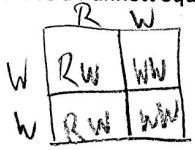
3. In snapdragons, flower color is controlled by incomplete dominance. The two alleles are red (R) and white (W). The heterozygous genotype is expressed as pink.

a. What is the phenotype of a plant with the genotype RR? Red

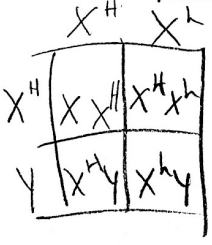
b. What is the phenotype of a plant with the genotype WW? White

c. What is the phenotype of a plant with the genotype RW? Pink

4. A pink-flowered plant is crossed with a white-flowered plant. What is the probability of producing a pink-flowered plant? Use a Punnett Square to show your work.



5. In humans, hemophilia is a sex-linked recessive trait. If a female who is a carrier for hemophilia has offspring with a male with normal blood clotting, what is the probability of having daughters with hemophilia? Having sons with hemophilia? Probability of carriers?



Student B:

Codominance/Incomplete Dominance & Sex-Linked Traits Genetics Quiz

Complete the following problems.

1. In some chickens, the gene for feather color is controlled by codominance. The allele for black is B and the allele for white is W. The heterozygous phenotype is known as erminette (black and white spotted).

a. What is the genotype for black chickens? BB

b. What is the genotype for white chickens? WW

c. What is the genotype for erminette chickens? BW

100%

2. Using a Punnett Square show the probability if two erminette chickens were crossed.

a. They would have a black chick? 25 %

b. They would have a white chick? 25 %

	B	W
B	BB	BW
W	BW	WW

3. In snapdragons, flower color is controlled by incomplete dominance. The two alleles are red (R) and white (W). The heterozygous genotype is expressed as pink.

a. What is the phenotype of a plant with the genotype RR? red

b. What is the phenotype of a plant with the genotype WW? white

c. What is the phenotype of a plant with the genotype RW? pink

4. A pink-flowered plant is crossed with a white-flowered plant. What is the probability of producing a pink-flowered plant? Use a Punnett Square to show your work.

	R	W
W	RW	WW
W	RW	WW

The probability is 50 %.

5. In humans, hemophilia is a sex-linked recessive trait. If a female who is a carrier for hemophilia has offspring with a male with normal blood clotting, what is the probability of having daughters with hemophilia? Having sons with hemophilia? Probability of carriers?

	X^H	X^h
X^H	X^HX^H	X^HX^h
Y	X^HY	X^hY

daughters with hemophilia: 0%

sons with hemophilia: 50%

Carriers: 25%

iii. Genetics Quiz

Student A:

Genetics Quiz

Matching – Match the following terms to the description that best fits.

g	1. Heterozygous	a. Passing of traits from parent to offspring
f	2. Homozygous	b. Two different alleles
b	3. Hybrid	c. Always expressed when present
d	4. Purebred	d. Two identical alleles
c	5. Dominant	e. Masked or hidden
e	6. Recessive	f. TT, tt
h	7. Allele	g. Tt
a	8. Heredity	h. The different forms of a gene

15/16

Short Answer

11. In mice, white fur is recessive to gray fur. Cross a white male with a heterozygous ~~brown~~ gray female, and find the possible genotypic and phenotypic ratios.

g	g
Gg	Gg
g	gg

The genotypic ratio is = 2 : 2 : 2 Gg : Gg : gg

The phenotypic ratio is = 2 : 2 gray fur : white fur

12. A man who has the ability to roll his tongue marries a woman who cannot roll her tongue. Both his parents were tongue rollers, and after genetic testing, he finds that he is homozygous dominant for tongue rolling, while his wife is homozygous recessive. Before they have children, he wants to find the possible genotypic and phenotypic ratios for their offspring. Help him find the answer!

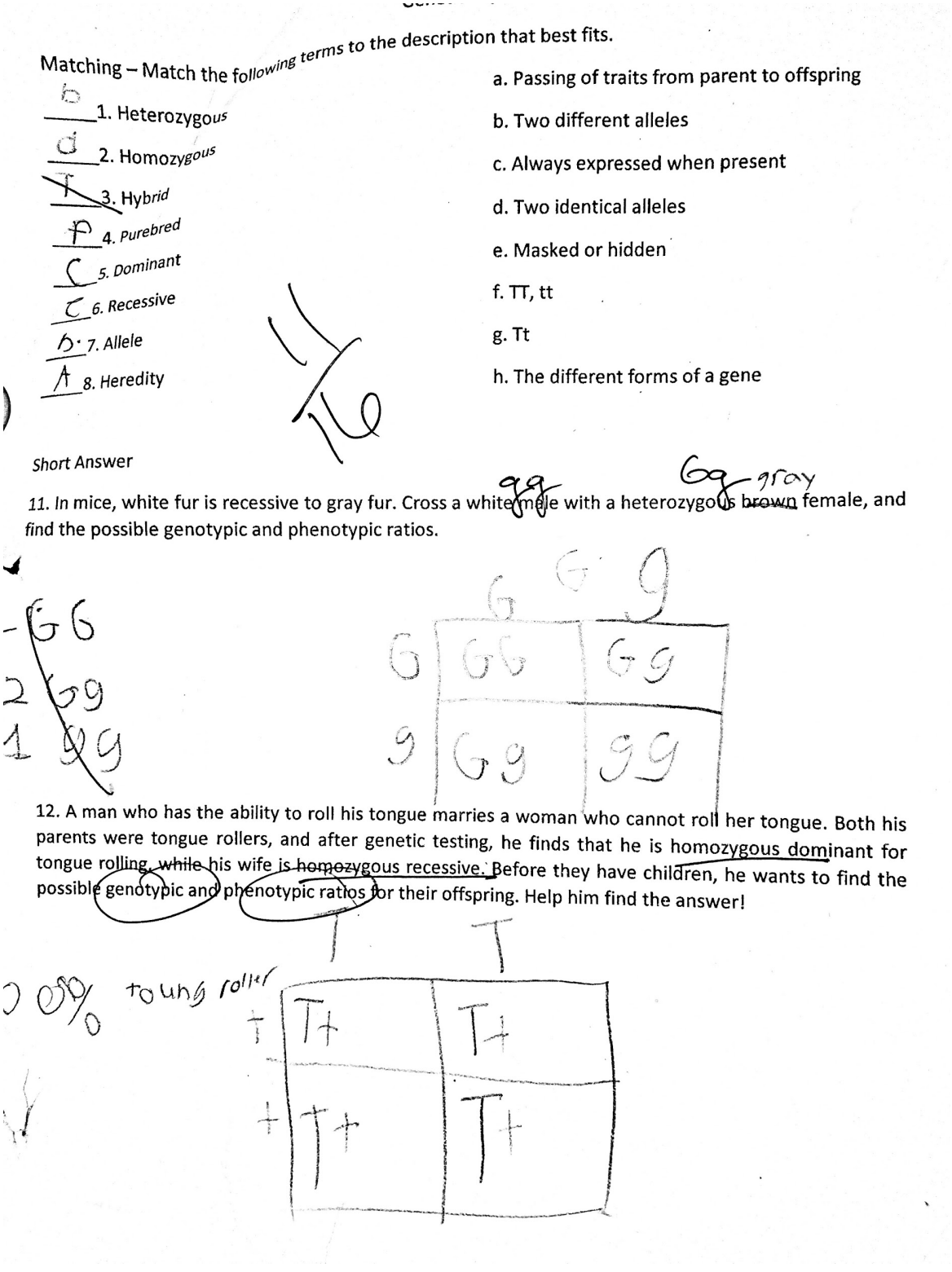
T	T
T+	T+
T+	T+

The genotypic ratio is = 0 : 4 : 0 TT : T+ : ++

The phenotypic ratio is = 4 : 0 tongue rollers : non-t rollers

The man will have children with the ability to roll their tongues; all of his kids.

Student B:



Matching – Match the following terms to the description that best fits.

b 1. Heterozygous
d 2. Homozygous
3. Hybrid
4. Purebred
5. Dominant
6. Recessive
7. Allele
8. Heredity

a. Passing of traits from parent to offspring
b. Two different alleles
c. Always expressed when present
d. Two identical alleles
e. Masked or hidden
f. TT, tt
g. Tt
h. The different forms of a gene

Short Answer

11. In mice, white fur is recessive to gray fur. Cross a white male with a heterozygous brown female, and find the possible genotypic and phenotypic ratios.

gg Gg gray

	G	g
G	GG	Gg
g	Gg	gg

12. A man who has the ability to roll his tongue marries a woman who cannot roll her tongue. Both his parents were tongue rollers, and after genetic testing, he finds that he is homozygous dominant for tongue rolling, while his wife is homozygous recessive. Before they have children, he wants to find the possible genotypic and phenotypic ratios for their offspring. Help him find the answer!

	T	T
t	Tt	Tt
t	Tt	Tt

100% tounge roller

Appendix F: Visualization of Mitosis for ELL Students

Oreo Mitosis Lesson: Click here to enter text.

Teacher's Name: Katie Nugent **Subject/Course: Science**
Unit: Genetics **Grade Level: 8th**

Overview of and Motivation for Lesson:
Click here to enter text.

Stage 1-Desired Results

Standard(s):
- Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes

Aim/Essential Question:
- How do cells replicate?

Understanding(s):
Students will understand that . . .
- in order to make identical cells a process called mitosis must occur. Mitosis happens in 4 phases, prophase, metaphase, anaphase, and telophase. Interphase and cytokinesis are also phases vital to cells.

Content Objectives:
Students will be able to . . .
- describe what occurs during the different phases of mitosis
- represent the phases of mitosis through the use of Oreos and sprinkles
- verbally communicate and visually draw the different phases to mitosis

Language Objectives:
ELD Level 2 *Students will be able to . . . in English*
Name the phases of Mitosis
ELD Level 5 *Students will be able to . . . in English*
- Summarizes what occurs in each phase of mitosis

Key Vocabulary
- mitosis
- interphase
- prophase
- metaphase
- anaphase
- telophase
- cytokinesis
- chromosomes
- centromere
- sister chromatids
- centrioles
- spindle fibers

Stage 2-Assessment Evidence

Performance Task or Key Evidence
- Click here to enter text.

Key Criteria to measure Performance Task or Key Evidence

- Click here to enter text.

Stage 3- Learning Plan

Learning Activities:

Do Now/Bell Ringer/Opener: The picture to the right shows a plants cell in a certain stage of mitosis. What phases occurs directly after this phase? (have picture of plant cell w cell plate)

Learning Activity 1:

Oreo Mitosis Activity
Student centered learning:
students will be in pairs with two groups at each table
each pair will be responsible for three phases of mitosis (including interphase and cytokinesis)
the pair will create the phases assigned to them in Oreos and sprinkles
after all phases are created, the two pairs will come together and place Oreos in the correct order.
Each pair will then have to explain the Oreo phase they created, helping all to fill out the diagram and description chart

Learning Activity 2:

Click here to enter text.

Application

Mitosis is the process by which our cuts heal

Summary/Closing

Click here to enter text.

Multiple Intelligences Addressed:

☐ Linguistic	☐ Logical-Mathematical	☐ Musical	☒Bodily-kinesthetic
☐ Spatial	☒ Interpersonal	☐Intrapersonal	☐Naturalistic

Student Grouping

☐ Whole Class	☒ Small Group	☒ Pairs	☐ Individual

Instructional Delivery Methods

☐ Teacher Modeling/Demonstration	☐ Lecture	☐ Discussion
☐ Cooperative Learning	☐ Centers	☐ Problem Solving
☒ Independent Projects		

Accommodations	**Modifications**
Click here to enter text.	Click here to enter text.

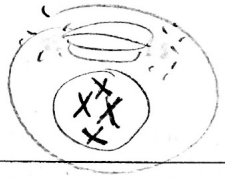
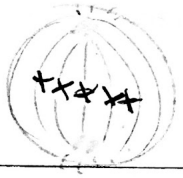
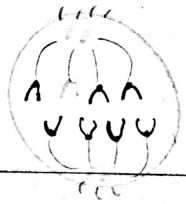
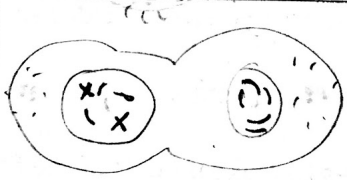
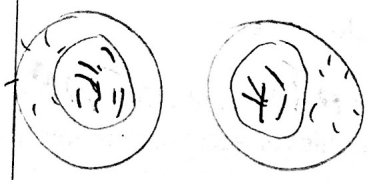
Homework/Extension Activities:
Finish Lab
Materials and Equipment Needed:
• Click here to enter text.

Adapted from Grant Wiggins and Jay McTighe-*Understanding by Design*

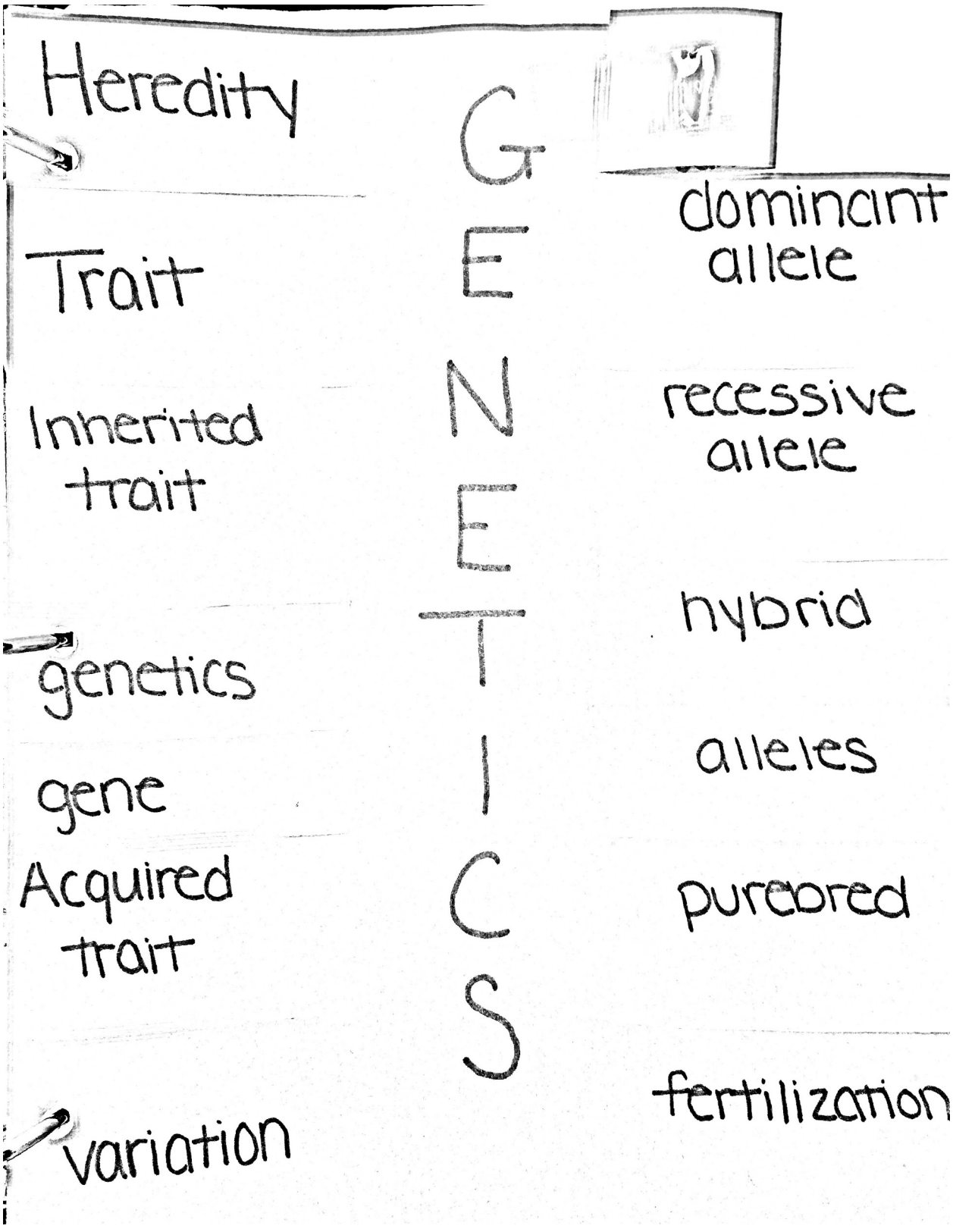
Goal: My meeting diverse needs goal for this lesson is to make the lesson student centered. This is done through the students having to explain the different phases of mitosis to their group. Different types of learning is also being used in this lesson, including, kinesthetic, visual, interpersonal, verbal, as well as auditory.

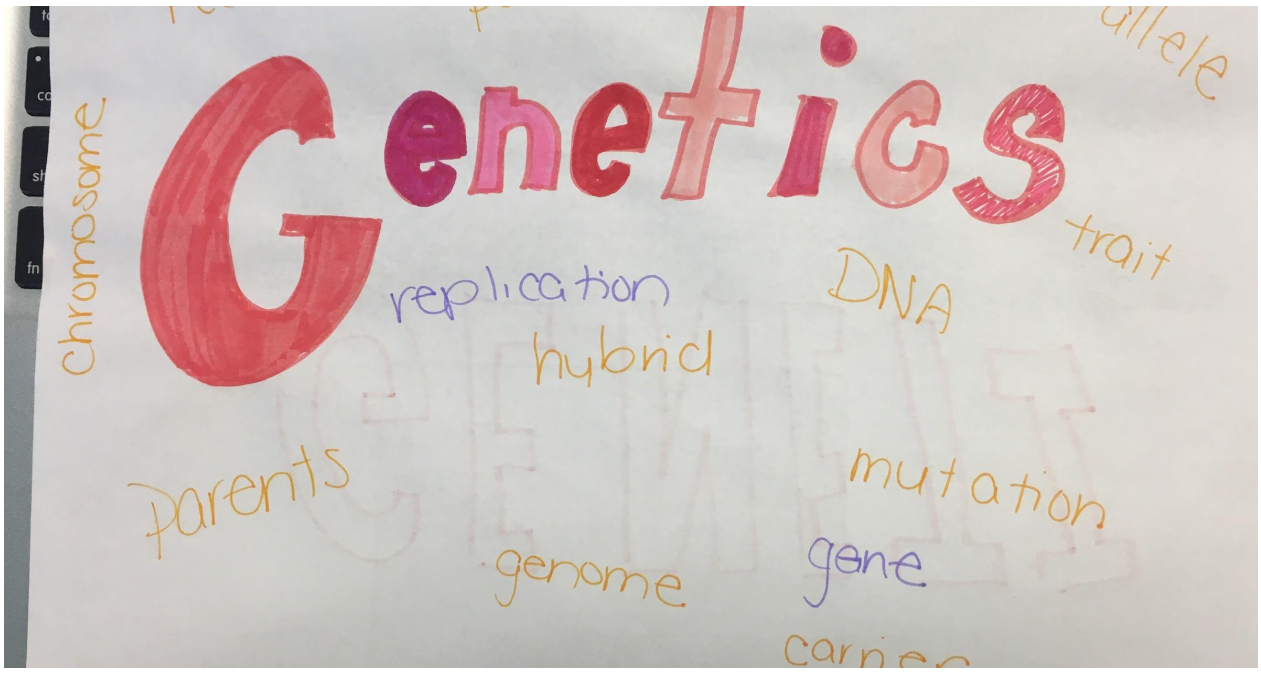
Data

Mitosis Data Table

Phase of Mitosis	Diagram	Description
Interphase		The cell grows, and makes a copy of it's DNA. Then prepps to divide into 2 cells. Centrioles are copied
Prophase		Chromatin condenses to form Chromosomes. Copied centrioles move to opposite sides of nucleus. Spindle fibers form bridge to each other. Nucleus disappears
Metaphase		Chromosomes line up in the middle. Each chromosome attaches to spindle fiber.
Anaphase		The centromeres split. 2 chromatids separate, each chromatid becomes a chromosome. Chromosomes move to opposite ends. Cell stretched. Pulls apart
Telophase		Chromosomes stretch out. New nucleus is formed. Cell looks pinched
Cytokinesis		Cell splits in 2. Each "daughter cell" has 2 identical sets of chromosomes.

Appendix G: Intro to Genetics Flipbook and Cover Page


Heredity
Trait
Inherited trait
genetics
gene
Acquired trait
variation
GENETICS
dominant allele
recessive allele
hybrid
alleles
purebred
fertilization



Appendix H: Modeling DNA with Gummy Bears Lab Activity

DNA MODEL: CONCLUSION QUESTIONS

Analysis Questions:

1. What base does adenine pair with?

Adenine pairs with Thymine

2. What base does guanine pair with?

Guanine pairs with Cytosine

3. Describe the shape of the DNA molecule. Draw a picture if it helps!

A DNA molecule looks like a twisted ladder

Connections:

1. What are the three components of a nucleotide? (HINT: What were the three components used in putting the model together? Remember that Adenine, Guanine, Cytosine, and Thymine are all Nitrogen Bases!) Refer to your DNA article if you are still unsure.

The three components of a nucleotide are Nitrogen bases, sugar and factate

2. What is the name of the sugar molecule in the DNA helix?

Riboose is the sugar molecule in the DNA helix

3. Suppose you know that the sequence of bases on one DNA strand (one side of the DNA ladder) is AGCTCAG. What is the sequence of the bases on the opposite strand?

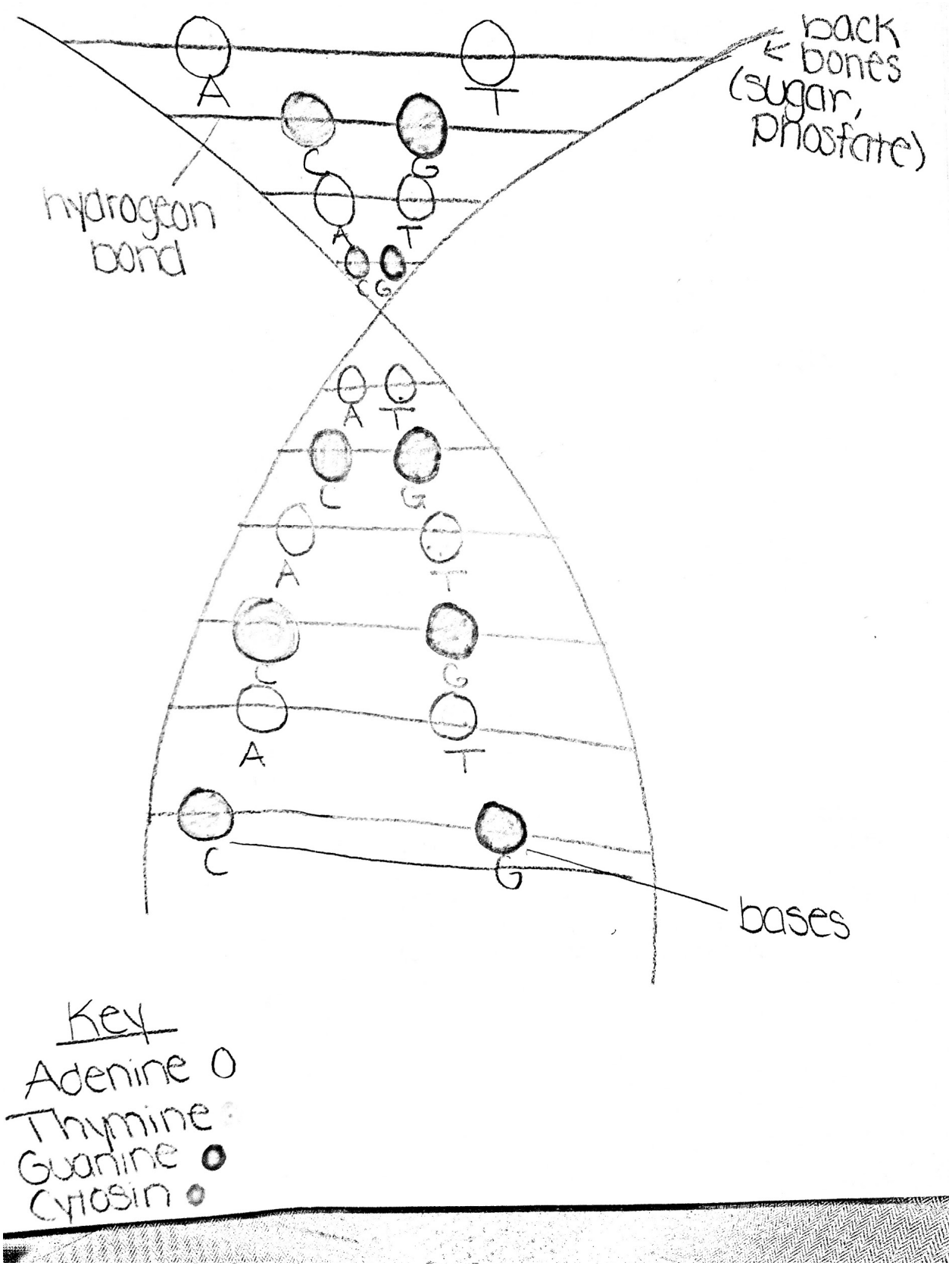
TCGAGTC

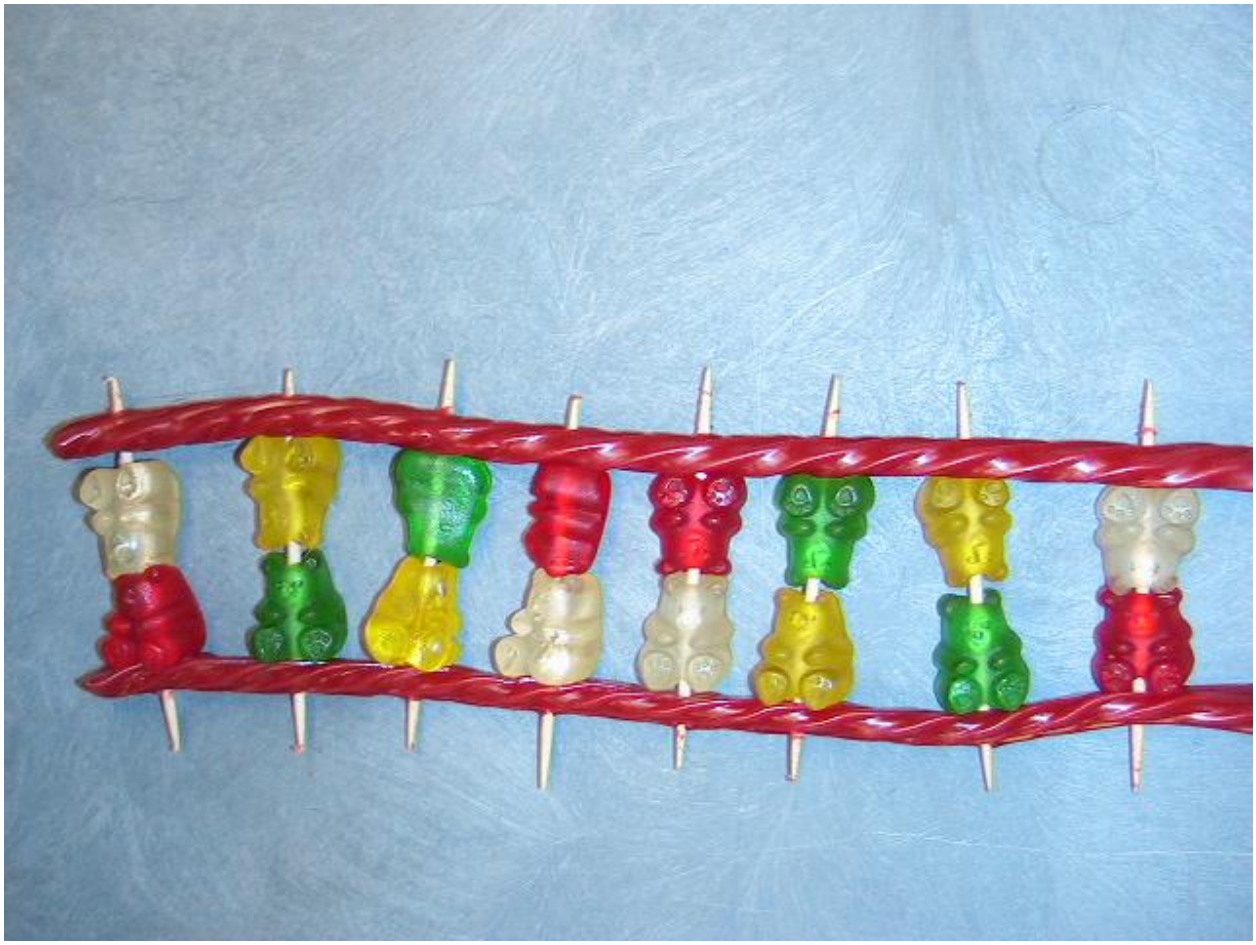
4. Assume that a 100-bair pair DNA double helix contains 45 cytosines. How many adenines are there?

There would be 55 adenines.

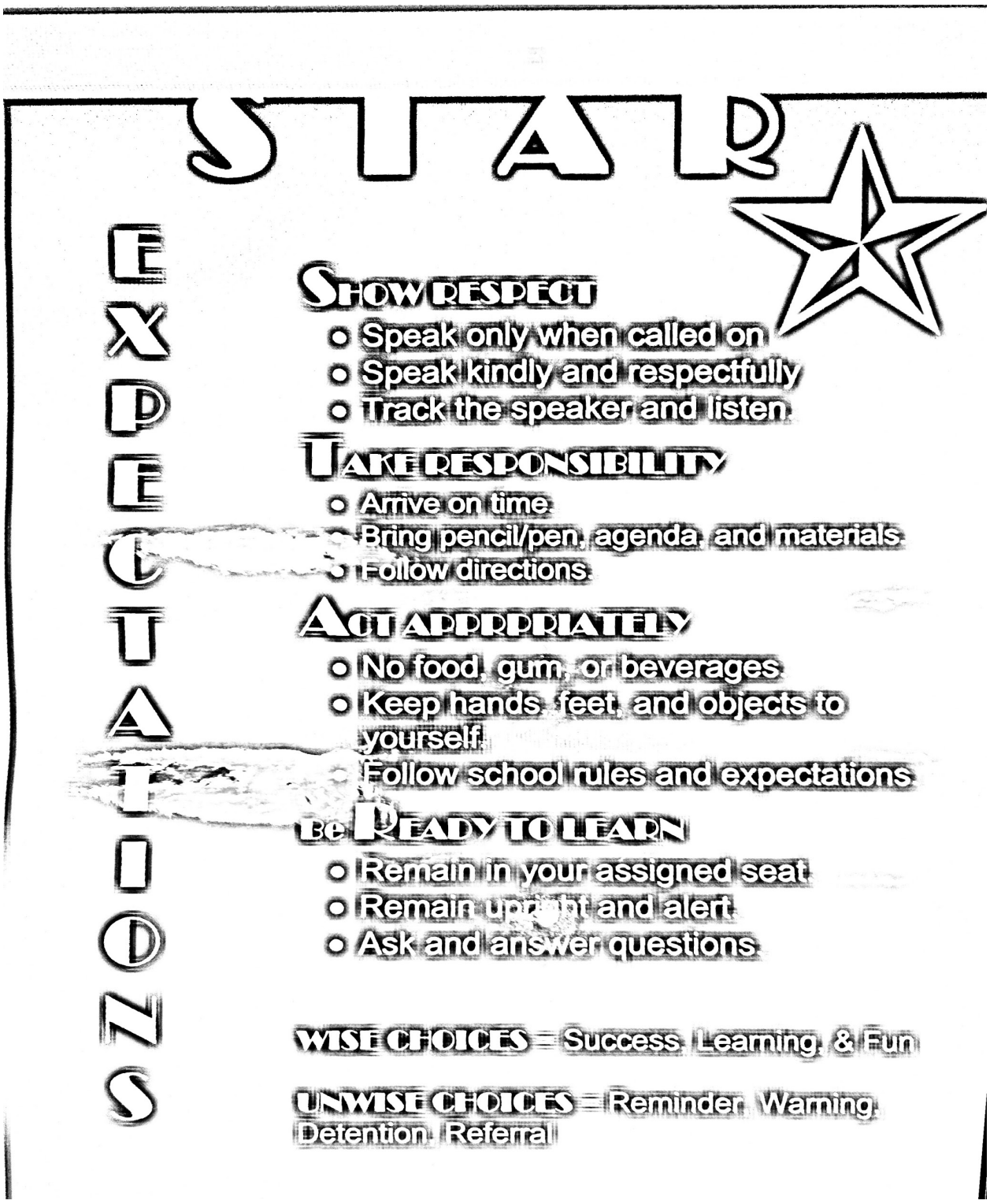
Conclusion: Write a summary of the structure of DNA that (at least) includes the terms: base, sugar, phosphate, nucleotide, (base) pair, and helix.

The shape of DNA is a double helix. The back bones are made of sugar nd phosphate and in between e the bases. Those are also e 3 components of a nucleotide.


back bones (sugar, phosfate)
hydrogen bond
A
T
C
G
bases
Key
Adenine O
Thymine
Guanine
Cytosin

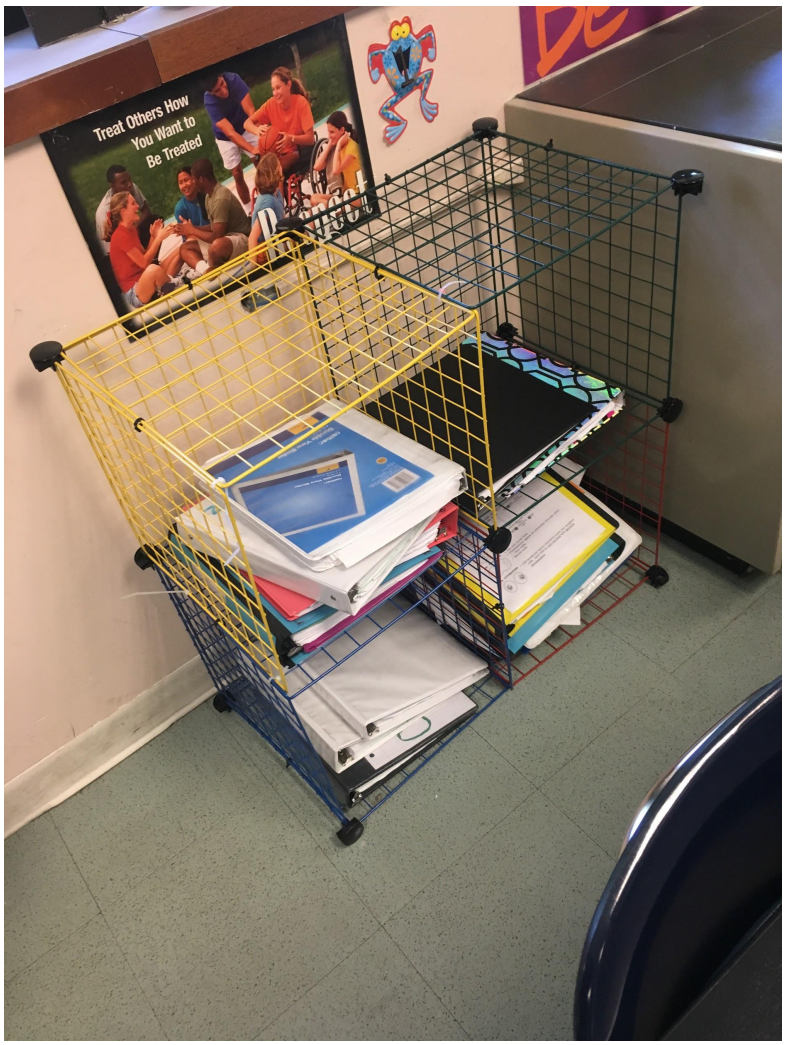


Appendix I: STAR Expectations



Appendix K: Classroom Set Up


WORD WALL
ATTENTION!
DNA & RNA
TRANSPORT



Appendix L: Student Surveys

CAP Student Feedback Survey

Grades 6-12: Short Form

Name of **teacher**: _____ Date: _____

Directions: Read each statement and then choose **one** answer choice that you think fits best. There are no right or wrong answers. Your teacher will use your class's responses to better understand what it's like to be a student in this class. Your teacher will not see your individual answers.

		Strongly Agree	Agree	Disagree	Strongly Disagree
1.	My teacher demonstrates that mistakes are a part of learning.	O	O	O	O
2.	My teacher asks us to summarize what we have learned in a lesson.	O	O	O	O
3.	Students push each other to do better work in this class.	O	O	O	O
4.	I am able to connect what we learn in this class to what we learn in other subjects.	O	O	O	O
5.	My teacher uses open-ended questions that enable me to think of multiple possible answers.	O	O	O	O
6.	In discussing my work, my teacher uses a positive tone even if my work needs improvement.	O	O	O	O
7.	In this class, students review each other's work and provide each other with helpful advice on how to improve.	O	O	O	O
8.	When asked, I can explain what I am learning and why.	O	O	O	O
9.	In this class, other students take the time to listen to my ideas.	O	O	O	O
10.	The level of my work in this class goes beyond what I thought I was able to do.	O	O	O	O
11.	The material in this class is clearly taught.	O	O	O	O
12.	If I finish my work early in class, my teacher has me do more challenging work.	O	O	O	O
13.	My teacher asks me to rate my understanding of what we have learned in class.	O	O	O	O
14.	To help me understand, my teacher uses my interests to explain difficult ideas to me.	O	O	O	O

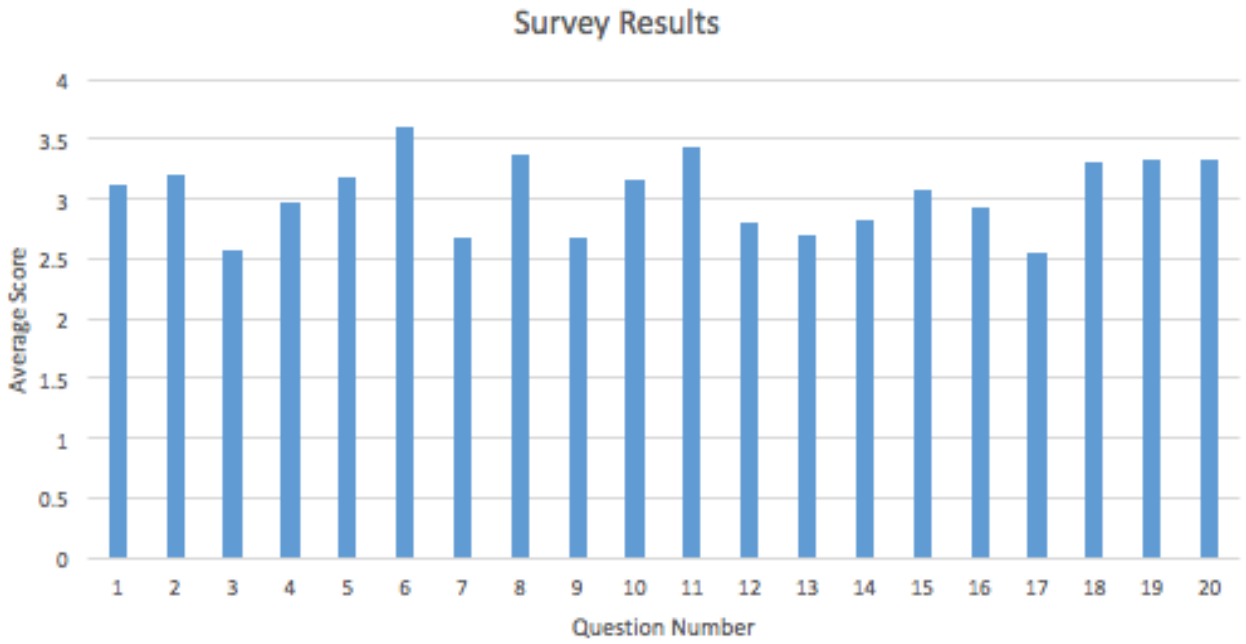
CAP Student Feedback Survey

Grades 6-12: Short Form

		Strongly Agree	Agree	Disagree	Strongly Disagree
15.	In this class, students work together to help each other learn difficult content.	O	O	O	O
16.	In this class, students are asked to teach (or model) to other classmates a part or whole lesson.	O	O	O	O
17.	Our class stays on task and does not waste time.	O	O	O	O
18.	During a lesson, my teacher is quick to change how he or she teaches if the class does not understand (e.g., switch from using written explanations to using diagrams).	O	O	O	O
19.	My teacher encourages us to accept different points of view when they are expressed in class.	O	O	O	O
20.	I can show my learning in many ways (e.g., writing, graphs, pictures) in this class.	O	O	O	O

OPTIONAL: If you have any additional feedback for your teacher, please share it here.

Appendix M: Survey Results



Appendix N: Post Assessment

Name: _____ Class: _____ Date: _____ ID: A

Post Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. What did Gregor Mendel do to study different characteristics in his genetics experiments?
   a. He studied only asexual plants.
   b. He studied only tall and short pea plants.
   c. He cross-pollinated plants.
   d. He cross-pollinated both plants and animals.

2. In Mendel's experiments, what proportion of the plants in the F_2 generation had a trait that had been absent in the F_1 generation?
   a. none
   b. one fourth
   c. half
   d. three fourths

3. Factors that control traits are called
   a. genes.
   b. purebreds.
   c. recessives.
   d. parents.

4. Scientists call an organism that has two different alleles for a trait a
   a. hybrid.
   b. trait.
   c. purebred.
   d. factor.

5. What does the notation *TT* mean to geneticists?
   a. two dominant alleles
   b. heterozygous alleles
   c. at least one dominant allele
   d. one dominant and one recessive allele

6. What does the notation *Tt* mean to geneticists?
   a. two dominant alleles
   b. two recessive alleles
   c. homozygous alleles
   d. one dominant allele and one recessive allele

7. What is probability?
   a. the actual results from a series of events
   b. a number that describes how likely it is that a event will occur
   c. the way the results of one event affect the ne event
   d. the number of times a coin lands heads up

8. What is the probability of producing a tall pea pla from a genetic cross between two hybrid tall pea plants?
   a. one in four
   b. two in four
   c. three in four
   d. four in four

9. What does a Punnett square show?
   a. all the possible outcomes of a genetic cross
   b. only the dominant alleles in a genetic cross
   c. only the recessive alleles in a genetic cross
   d. all of Mendel's discoveries about genetic crosses

10. If a homozygous black guinea pig (*BB*) is crossed with a homozygous white guinea pig (*bb*), what is the probability that an offspring will have black fur?
    a. 25 percent
    b. 50 percent
    c. 75 percent
    d. 100 percent

11. An organism's physical appearance is its
    a. genotype.
    b. phenotype.
    c. codominance.
    d. heterozygous.

Name: _____ ID:

12. A purebred chicken with white feathers is crossed with a purebred chicken that has black feathers. Each of their offspring has both black and white feathers. Why does this happen?
    a. Both alleles for feather color are dominant.
    b. Both alleles for feather color are recessive.
    c. The alleles for feather color are neither dominant nor recessive.
    d. Several alleles work together to determine the trait.

13. What is the chromosome theory of inheritance?
    a. Chromosomes are carried from parents to offspring on hybrids.
    b. Genes are carried from parents to offspring on chromosomes.
    c. Hybrid pairs of chromosomes combine to form offspring.
    d. Codominant genes combine to form new hybrids.

14. What happens during meiosis?
    a. Two sex cells combine.
    b. Chromosome pairs separate and are distributed into new sex cells.
    c. Each sex cell copies itself to form four new chromosomes.
    d. Chromosome pairs remain together when new sex cells are formed.

15. When sex cells combine to produce offspring, each sex cell will contribute
    a. one fourth the number of chromosomes in body cells.
    b. half the number of chromosomes in body cells.
    c. the normal number of chromosomes in body cells.
    d. twice the number of chromosomes in body cells.

16. What determines the genetic code?
    a. the order of nitrogen bases along a gene
    b. the number of nitrogen bases in a DNA molecule
    c. the order of amino acids in a protein
    d. the number of guanine and cytosine bases in a chromosome

17. What is a mutation?
    a. any change that is harmful to an organism
    b. any change in a gene or chromosome
    c. any change that is helpful to an organism
    d. any change in the phenotype of a cell

18. A mutation is harmful to an organism if it
    a. changes the DNA of the organism.
    b. changes the phenotype of the organism.
    c. reduces the organism's chances for survival and reproduction.
    d. makes the organism better able to avoid predators.

19. Which term refers to physical characteristics that are studied in genetics?
    a. traits
    b. offspring
    c. generations
    d. hybrids

20. The different forms of a gene are called
    a. alleles.
    b. factors.
    c. masks.
    d. traits.

21. Where does protein synthesis take place?
    a. in the ribosomes in the nucleus of the cell
    b. on the ribosomes in the cytoplasm of the cell
    c. in the chromosomes in the nucleus of the cell
    d. on the chromosomes in the cytoplasm of the cell

22. An organism's genotype is its
    a. genetic makeup.
    b. feather color.
    c. physical appearance.
    d. stem height.

23. Which nitrogen base in RNA is NOT part of DNA?
    a. adenine
    b. guanine
    c. cytosine
    d. uracil

24. An organism that has two identical alleles for a trait is
    a. codominant.
    b. tall.
    c. homozygous.
    d. heterozygous.

25. A heterozygous organism has
    a. three different alleles for a trait.
    b. two identical alleles for a trait.
    c. only one allele for a trait.
    d. two different alleles for a trait.

26. Chromosomes are made up of
    a. one pair of alleles.
    b. many traits joined together.
    c. transfer RNA.
    d. many genes joined together.

27. What are multiple alleles?
    a. more than two genes that control a trait
    b. three or more forms of a gene that code for a single trait
    c. three or more chromosomes that determine a trait
    d. more than two codominant genes in a chromosome

28. Which of these human traits is altered by variations in environment?
    a. hairline
    b. height
    c. smile dimples
    d. blood type

29. What factors can affect a person's height?
    a. genes only
    b. both genes and environmental factors
    c. a person's blood type
    d. a person's karyotype

30. Which combination of sex chromosomes results in a male human being?
    a. XX
    b. YY
    c. XY
    d. either XX or YY

31. Why are sex-linked traits more common in males than in females?
    a. All alleles on the X chromosome are dominant.
    b. All alleles on the Y chromosome are recessive.
    c. A recessive allele on the X chromosome will always produce the trait in a male.
    d. Any allele on the Y chromosome will be codominant with the matching allele on the X chromosome.

32. How does a geneticist use pedigrees?
    a. to create genetic crosses
    b. to replicate identical strings of DNA
    c. to prove that sex-linked traits are caused by codominant alleles
    d. to trace the inheritance of traits in humans

33. What is a pedigree?
    a. a chart that tracks which members of a family have a particular trait
    b. a geneticist who studies the inheritance of traits in humans
    c. a picture of all of the chromosomes in a cell
    d. an allele passed from parent to child on a sex chromosome

34. Genetic disorders are caused by
    a. pedigrees.
    b. DNA mutations or changes in chromosomes.
    c. dominant alleles only.
    d. recessive alleles only.

35. What is a karyotype?
    a. a sex-linked genetic disorder
    b. a picture of a baby before it is born
    c. a picture of the chromosomes in a cell
    d. fluid that surrounds a baby before it is born

36. Sex-linked genes are genes on
    a. the X chromosome only.
    b. the Y chromosome only.
    c. the X and Y chromosomes.
    d. all 23 pairs of chromosomes.

37. A carrier is a person who has
    a. one recessive and one dominant allele for a trait.
    b. two recessive alleles for a trait.
    c. two dominant alleles for a trait.
    d. more than two alleles for a trait.

Name: _____

38. Many characteristics are affected by interactions between genes and
    a. chromosomes.
    b. the environment.
    c. alleles.
    d. carriers.

39. Mitosis is the stage of the cell cycle during which
    a. the cell's nucleus divides into two new nuclei.
    b. the cell's DNA is replicated.
    c. the cell divides into two new cells.
    d. the cell's cytoplasm divides.

40. What happens during cytokinesis in animal cells?
    a. A new round of mitosis begins.
    b. Two new daughter cells are formed.
    c. Each organelle divides into two parts.
    d. A cell plate forms in the middle of the cell.

41. A DNA molecule is shaped like a
    a. long, thin rod.
    b. spiral staircase.
    c. straight ladder.
    d. triple helix.

42. During DNA replication, adenine (A) always pairs with
    a. guanine (G).
    b. cytosine (C).
    c. thymine (T).
    d. adenine (A).

43. Cancer is a disease in which cells
    a. grow and divide uncontrollably.
    b. die before they can mature.
    c. stop producing DNA.
    d. die during mitosis.

44. Each rung of the DNA ladder is made of
    a. a single nitrogen base.
    b. a pair of nitrogen bases.
    c. three nitrogen bases.
    d. four nitrogen bases.

45. During what stage of the cell cycle does replication occur?
    a. interphase
    b. cytokinesis
    c. prophase
    d. mitosis

46. What is copied during replication?
    a. the cell's organelles
    b. chromosomes
    c. the cell's DNA
    d. two daughter cells

47. What are chromatids?
    a. identical strands of chromosomes
    b. identical daughter cells
    c. doubled rods of condensed chromatin
    d. pigments that absorb the energy in sunlight

48. What forms around the chromatids during mitosis?
    a. two new chromosomes
    b. two new nuclei
    c. two new cells
    d. two new DNA molecules

49. The stage of the cell cycle that follows mitosis is called
    a. interphase.
    b. metaphase.
    c. cytokinesis.
    d. telophase.

50. The regular cycle of growth and division that cells undergo is called
    a. replication.
    b. the cell cycle.
    c. interphase.
    d. mitosis.